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The Environmental Protection Agency Four Corners Ambient Air Monitoring Network

Interagency Energy-Environment Research and Development Program Report

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16. ABSTRACT
This ambient air monitoring program was initiated with the overall objective of establishing an air quality baseline for the Four Corners area of Arizona, Colorado, New Mexico, and Utah. The baseline will be used in assessing the impact of the development of coal deposits and the operation of large, coal-fired, electrical generating plants in the Four Corners area.

The network of 29 monitoring stations was established to obtain data concerning the air quality in a predominantly rural area covering a multistate region. Results are evaluated in terms of the total suspended particulates present in the ambient air at each of the 29 stations on a seasonal basis from the winter of 1975-76 through the winder of 1976-77. These data are evaluated in terms of the validity of the sampling and analytical procedures, and are available from the National Aerometric Data Base using the SAROAD system.

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THE ENVIRONMENTAL PROTECTION AGENCY FOUR CORNERS AMBIENT AIR MONITORING NETWORK

by

D.E. Smith, O.K. Spencer, J. Richards, and G. Peterson

Ute Research Laboratories
P.O. Box 266
Ft. Duchesne, Utah 84026

and

P.O. Box 659
Blanding, Utah 84511

Contract No. 68-03-2345

Project Officer

Robert Snelling
U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
P.O. Box 15027
Las Vegas, Nevada 89114

ENVIRONMENTAL MONITORING AND SUPPORT LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89114

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FOREWORD

Protection of the environment requires effective regulatory actions that are based on sound technical and scientific information. This information must include the quantitative description and linking of pollutant sources, transport mechanisms, interactions, and resulting effects on man and his environment. Because of the complexities involved, assessment of specific pollutants in the environment requires a total systems approach that transcends the media of air, water, and land. The Environmental Monitoring and Support Laboratory-Las Vegas contributes to the formation and enhancement of a sound monitoring data base for exposure assessment through programs designed to:

- develop and optimize systems and strategies for monitoring pollutants and their impact on the environment
- demonstrate new monitoring systems and technologies by applying them to fulfill special monitoring needs of the Agency's operating programs.

This report describes an ambient air monitoring network established to determine an air quality base line for the Four Corners area of Arizona, Colorado, New Mexico, and Utah. The data base thus obtained, and the continued operation of the monitoring network, subsequently will be used to assess the impact of coal deposit development and the activation of large, coal-fired, electrical generating plants in the Four Corners area.

The description of this monitoring network and of the initial results obtained from the network should be of value to those individuals concerned with the quality of the environment in the Four Corners area, as well as to those interested in planning or implementing similar programs for other areas of the country.

Additional information may be obtained from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, P.O. Box 15027, Las Vegas, Nevada 89114.

George B. Morgan
Director
Environmental Monitoring and Support Laboratory
Las Vegas

PREFACE

A steadily increasing demand for energy, combined with the need for reducing the consumption of limited and costly oil and natural gas supplies for the generation of electrical power, has resulted in an accelerated development of extensive coal deposits in the Four Corners area of northeastern Arizona, southwestern Colorado, northwestern New Mexico, and southeastern Utah. The proximity and availability of such coal supplies has led, in turn, to the construction and activation of large, coal-fired, electrical generating plants throughout the same geographical area.

With such a surge in development, protection of the environment has become a vitally important consideration. Previously, most of the area has been rural, containing few large population centers but many historic, cultural, and recreational areas. The introduction of large-scale industrial activities into this area is seen by many to constitute a potential or actual threat to the environment and has caused considerable concern in view of the impact on the physical qualities of the area, the residents, and the visitors.

Under contract to the U.S. Environmental Protection Agency, Ute Research Laboratories has undertaken the planning, design, and implementation of an ambient air quality monitoring network, together with qualitative and quantitative studies, to develop a data base for rural air quality in this area. Subsequently, this data base will be used with continuing monitoring programs to assess the impact of the industrial development. The monitoring network and the associated studies have been designed to allow correlation of numerous factors affecting air quality, including the atmospheric pollutants, their relative levels over periods of time, the extent of their spread throughout the area, and a variety of contributing factors such as prevailing winds, geography, etc.

In this, the first published report on the program, information is presented concerning the way the program operates, the methods applied, and the early results in the development of the data base. Most of the efforts during this initial phase of the program have been devoted to establishing accurate and reliable methods for obtaining data, analyzing samples, and evaluating results so that subsequent phases will be based on procedures that yield statistically valid results.

ABSTRACT

This ambient air monitoring program was initiated with the overall objective of establishing an air quality base line for the Four Corners area of Arizona, Colorado, New Mexico, and Utah. The base line will be used in assessing the impact of the development of coal deposits and the operation of large, coal-fired, electrical generating plants in the Four Corners area.

A network of 29 monitoring stations was established to obtain data concerning the air quality in a predominantly rural area covering a multistate region. Analytical procedures were designed and implemented to analyze samples extracted from ambient air for their content of trace metals, sulfates, and nitrates. Quality control procedures were developed and implemented to assure statistically accurate and reliable sampling and analysis techniques that would provide a valid data base.

Results are evaluated in terms of the total suspended particulates present in the ambient air at each of the 29 monitoring stations on a seasonal basis from the winter season of 1975-1976 through the winter season of 1976-1977. Results also are evaluated in terms of the validity of the sampling and analytical procedures. These data also are available from the National Aerometric Data Base, using the SAROAD (Storage and Retrieval of Aerometric Data) system.

This report was submitted in partial fulfillment of Contract No. 68-03-2345 by Ute Research Laboratories under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period from November, 1975, to November, 1977, and work was completed as of January 1, 1978. Actual data collecting was limited to a period commencing December 1, 1975, and ending February 28, 1977.

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LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

C	-- Celsius scale of temperature measurement
cfm	-- cubic feet per minute
cm	-- centimeter
dm	-- decimeter (1.0 cubic decimeter equals 1.0 liter)
EMSL-LV	-- Environmental Monitoring and Support Laboratory-Las Vegas
EPA	-- United States Environmental Protection Agency
F	-- Fahrenheit scale of temperature measurement
ft	-- foot
hr	-- hour
in	-- inch
km	-- kilometer
m	-- meter
mg	-- milligram
mi	-- mile
min	-- minute
ml	-- milliliter
mm	-- millimeter
μg	-- microgram
$\mu g/m^3$	-- microgram per cubic meter
μm	-- micrometer (1.0 micrometer is the same as 1.0 "micron")
N/A	-- not activated; tabular entry for nonactivated station
rad/s	-- radians per second
s	-- second
SAROAD	-- Storage and Retrieval of Aerometric Data
TSP	-- Total Suspended Particulates

SYMBOLS

Cd	-- cadmium
Co	-- cobalt
Cr	-- chromium
Cu	-- copper
Fe	-- iron
HCl	-- hydrochloric acid
HNO_3	-- nitric acid
Mn	-- manganese
Mo	-- molybdenum
Ni	-- nickel
Pb	-- lead

ACKNOWLEDGMENTS

The cooperation of the United States National Park Service is gratefully acknowledged. Without its assistance, operation of the monitoring stations at Lee's Ferry, AZ (Glen Canyon National Recreation Area), and at Chaco Canyon, NM (Chaco Canyon National Monument), would not have been possible. National Park Service personnel in these two areas have been responsible for the overall operation of the monitoring stations.

We also acknowledge the assistance of the Navajo, Hopi, Mountain Ute, Southern Ute, Kaibab Piute, and Jicarilla Apache Indian Tribes in permitting the use of tribal lands for some stations and for their help in obtaining personnel to operate these stations.

Rockwell International laboratories has furnished valuable support in the creation and implementation of quality assurance procedures for this study. Personnel at Rockwell International developed an extensive quality assurance program, provided audits of the laboratory procedures used by Ute Research Laboratories, furnished standardized samples, and made other important contributions to the validity of the results obtained from sample collection and analysis.

Ernest E. Mau, an independent documentation consultant helped prepare this report for publication.

SECTION 1

INTRODUCTION

Steadily increasing energy demands and a need to reduce the amounts of oil and natural gas used for generating electricity have subjected the Four Corners area of Arizona, Colorado, New Mexico, and Utah to a surge of industrial activity. As extensive native coal deposits are being developed, their proximity and availability have led to the construction and activation of coal-fired electrical generating plants in and around the Four Corners area.

Ute Research Laboratories has developed and implemented an extensive study program to accumulate, analyze, and correlate ambient air quality data that will provide the base line for evaluating the present and future impacts of industrial activity in the Four Corners area. Included in this program are the establishment and operation of a monitoring network of 29 stations, the development of analytical procedures for quantitative identification of suspended particulates at each monitoring station, and the development of quality assurance procedures that assure the accuracy and validity of all samples, measurements, and analytical techniques. Further efforts are being devoted to correlating the data with a variety of factors affecting the transport of airborne pollutants from their sources to the monitoring locations. Some of these factors are prevailing winds and air currents, the geographical characteristics of the affected terrain, and seasonal variations such as the frequency of storms and wind shifts.

In this initial phase of the program, data will be evaluated as a base line, relatively unaffected by the new pollutant sources, for comparison with future data obtained as the area is developed. In combination with other studies, this study and its base-line data will permit the assessment of the impact of coal development and power plant activation as the activity progresses. If any environmental degradation occurs, it should be apparent immediately as an increased level of contamination at the monitoring locations.

The present phase of this program focuses on the implementation of the monitoring network, the analytical procedures, and the quality assurance measures taken to establish a meaningful base line.

SECTION 2

CONCLUSIONS

Accepting the overall objective of this program as being the development and implementation of an extensive, accurate, reliable, and valid monitoring system for measuring selected ambient air quality parameters in a rural environment, the program has been a success.

As of the closing date of this report (February 28, 1977, for the collection of air samples and November 30, 1977, for procedural methods), an extensive monitoring network had been established and placed into regular operation. The procedures for handling and transmitting samples and data were implemented with little difficulty. Analytical laboratory techniques were established to develop meaningful data, and a quality assurance program was implemented to document the validity of the results.

The quality assurance program indicated some defects in laboratory procedures, primarily affecting the trace-metal analysis. Changes to the laboratory techniques were incorporated, beginning with the samples collected July 1, 1977. However, the data in this report do not reflect the changes to the laboratory techniques.

Multistate ambient air monitoring on a scale such as this has proven to be a workable concept. The data accumulated by the operation of this monitoring network are expected to become invaluable in assessing the present and future impact of large-scale industrial development in the Four Corners area.

SECTION 3

RECOMMENDATIONS

Thus far, this program has been limited to developing and implementing monitoring and analysis techniques for a limited range of air pollutants within the geographical area of concern. Now that the sampling and analysis techniques for total suspended particulates (TSP), specified trace metals, sulfates, and nitrates have been implemented, it is necessary to start correlating the measurements with other data affecting the transport of pollutants (winds, precipitation, etc.) and the effects of other factors such as terrain, vegetation, soil composition, etc.

A soil analysis program, now being conducted, is designed to determine the concentrations of metals in the soil at and around the various monitoring stations. High concentrations of iron oxides in the rocks and soil near the monitoring stations may be affecting the iron content of the samples. Concentrations of other metallic compounds may have similar effects. Hopefully, the soil analyses will indicate where and to what extent these native elements may be expected to contribute to the air quality measurements.

Additional consideration should be given to collecting appropriate meteorological data. At present, the data are limited to the field operator's judgment of weather conditions during the sampling periods, and they rely on the operator's ability to gauge the average wind conditions, the presence or absence of storms and precipitation, etc. At least some of the monitoring stations should be equipped with sufficient meteorological instrumentation and chart recorders to provide a continuous measurement of wind speed and direction, barometric pressure, humidity, temperature, and measurable precipitation. Meteorological data may provide the only means of correlating measurements with individual sources for stations within the affected radii of more than one source.

SECTION 4

THE MONITORING NETWORK

GENERAL DESCRIPTION

The 29 monitoring stations that constitute the ambient air monitoring network were selected to provide measurements typical of rural background values in and around the Four Corners area expected to be most affected by the development of coal deposits and the construction and activation of the electrical generating plants. The sites are considered representative of existing rural air quality throughout the area, and they are likely to reflect any environmental degradation as a result of emissions from the industrial activity now beginning.

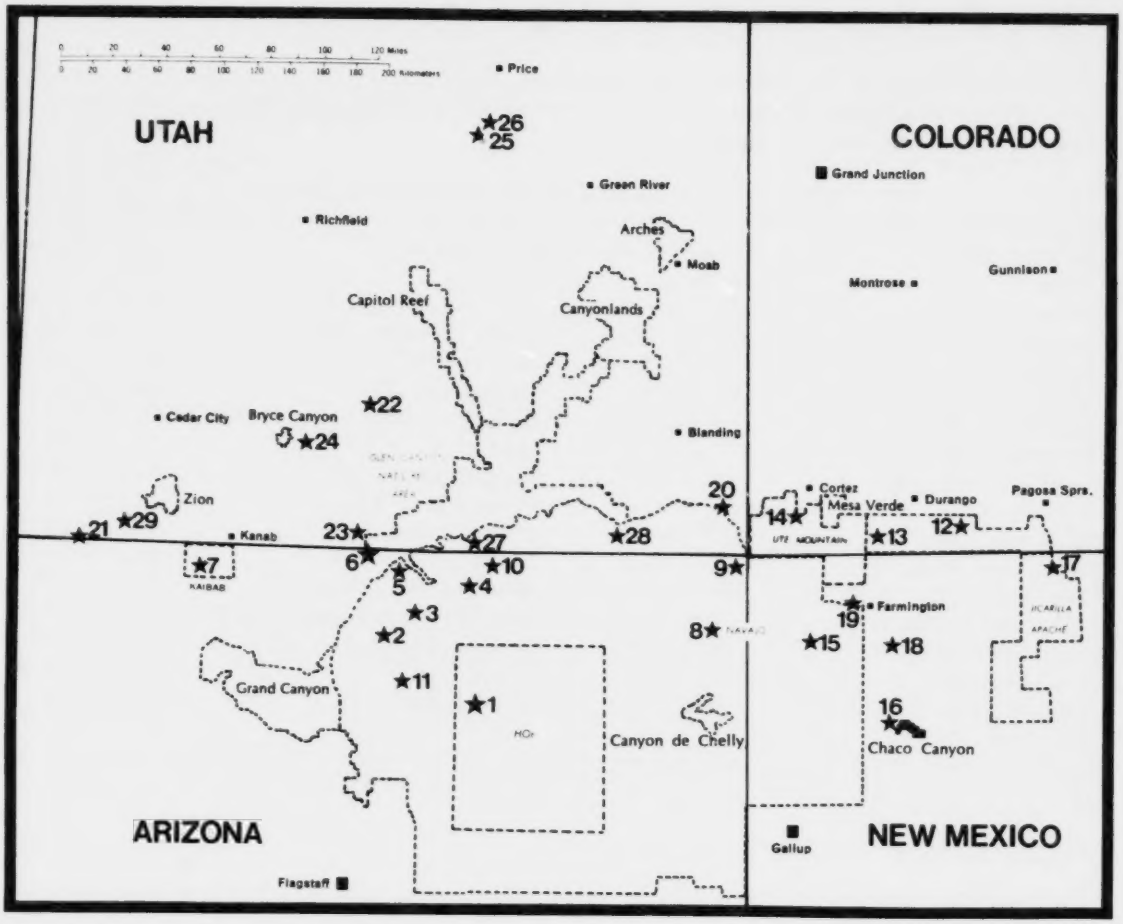
The exact location of each monitoring station was influenced by considerations including the site's suitability to the purposes and objectives of the monitoring program, the availability of personnel to operate the station, the availability of electrical power for the equipment, and the accessibility of the site.

To effectively manage the monitoring program, Ute Research Laboratories established a field office in Blanding, UT. This office is responsible for the overall management of the program, including personnel assignments and schedules, equipment maintenance, instrument calibration, data processing and submission, and report preparation. The field office also handles all communications with the Ute Research Laboratories' main office in Ft. Duchesne, UT, and with the field personnel responsible for the operation of the individual monitoring stations.

MONITORING SITE LOCATIONS

Figure 1 shows the locations of the 29 monitoring stations that are providing data for this program. The network consists of 11 stations in Arizona, 3 in Colorado, 5 in New Mexico, and 10 in Utah.

The two Huntington Canyon stations, near central Utah and distant from Four Corners, have been established specifically to monitor the effects of emissions from the Huntington Power Plant on the local ambient air quality. Additional information on the individual monitoring stations is contained in Appendix B, including further definition of their locations and the immediate terrain surrounding and influencing each station.



★ indicates Ute Research Laboratories' monitoring stations:

1 Bacobi, AZ
2 Bodaway, AZ
3 Coppermine, AZ
4 Kaibito, AZ
5 Lechee, AZ
6 Lee's Ferry, AZ
7 Piute, AZ
8 Redrock, AZ
9 Teec Nos Pos, AZ
10 Tsa Schizzi, AZ
11 Tuba City, AZ
12 Ignacio, CO
13 Redmesa, CO
14 Towaoc, CO
15 Burnham, NM
16 Chaco Canyon, NM
17 Dulce, NM
18 Huerfano, NM
19 Navajo Farm Proj., NM
20 Aneth, UT
21 Bloomington, UT
22 Escalante, UT
23 Glen Canyon, UT
24 Henrieville, UT
25 Huntington Canyon #1, UT
26 Huntington Canyon #2, UT
27 Navajo Mountain, UT
28 Oljato, UT
29 St. George, UT

Figure 1. Monitoring site locations.

MONITORING SITE ACTIVATION

Table 1 lists the activation dates of the various monitoring stations. Most of the stations originally were activated during a previous study and were reactivated for this one.

TABLE 1. MONITORING SITE ACTIVATION DATES

Monitoring Site	Activation Date	Monitoring Site	Activation Date
Bacobi, AZ	02/27/76	Chaco Canyon, NM	06/30/76
Bodaway, AZ	06/21/76	Dulce, NM	05/17/76
Coppermine, AZ	02/02/76	Huerfano, NM	04/13/76
Kaibito, AZ	01/22/76	Navajo Farm Project, NM	02/06/77
Lechee, AZ	05/22/77	Aneth, UT	02/11/76
Lee's Ferry, AZ	10/05/76	Bloomington, UT	02/02/76
Piute, AZ	01/27/76	Escalante, UT	01/24/76
Redrock, AZ	01/12/76	Glen Canyon, UT	10/13/76
Teec Nos Pos, AZ	01/20/76	Henrieville, UT	01/24/76
Tsa Schizzi, AZ	04/02/76	Huntington Canyon #1, UT	04/18/77
Tuba City, AZ	02/16/76	Huntington Canyon #2, UT	05/06/77
Ignacio, CO	01/19/76	Navajo Mountain, UT	01/30/77
Redmesa, CO	04/19/76	Oljato, UT	01/23/76
Towaoc, CO	04/29/76	St. George, UT	07/14/76
Burnham, NM	05/17/76		

MONITORING SITE EQUIPMENT

The air sampling equipment at each station is mounted on a 4.6-meter (m) [15-foot (ft)] tower, with the intent of minimizing the effects of local dust and other ground-level interferences on the air samples obtained.

High-Volume Air Samplers

With the exception of the Navajo Farm Project in New Mexico, each station is equipped with a high-volume air sampler. These samplers are standard, commercial units and are equipped with continuous flow recorders. Prior to the start of this program, most of these samplers had been fitted with new motors to assure reliable operation.

The filters used in the high-volume air samplers are spectrographic grade, Type A, glass-fiber filters that measure 203 by 254 millimeters (mm) [8 by 10 inches (in)]. The filters are rated at 99.9% retention for particles measuring 0.3 micrometer (μm) and larger. New filters are installed in each sampler prior to the start of each 24-hour (hr) sampling period. At the end of the sampling period, the filters are removed, inserted into storage folders on which associated data also are recorded, and submitted for analysis.

In addition to the regular high-volume air sampler, the station at Henrieville, UT, has been equipped with a second high-volume air sampler. At the request of the Environmental Monitoring and Support Laboratory-Las Vegas (EMSL-LV), this second sampler has been fitted with a two-stage sampling head that separates the captured particulates into two size ranges. This is part of an evaluation to enable the EMSL-LV to appraise this particle-size discriminating sampler and its potential value for this and other programs. The filter samples from this two-stage sampler also are prepared and submitted for analysis (refer to Appendix C for additional information).

Low-Volume Air Samplers

Two of the stations are equipped with low-volume air samplers. At Lechee, AZ, the low-volume sampler is used in addition to the regular high-volume sampler. At Navajo Farm Project, NM, the low-volume sampler is used exclusively.

The low-volume air samplers also are standard, commercial units. However, they are not equipped with flow recorders, but are equipped with standard magnehelic gauges that measure the airflow through the units.

The low-volume samplers use membrane-type filters, measuring 102 mm (4.0 in) in diameter and having a rated retention of 99% for particles measuring 0.45 μm and larger. Like the high-volume samplers, the filters for the low-volume samplers are installed prior to the start of each sampling period. At the end of each 24-hr sampling period, the filters are removed, inserted into storage folders on which associated data are recorded, and submitted for analysis.

Three-Stage Multiday Cascade Impactor

At the request of the EMSL-LV, the station at Henrieville, UT, also has been equipped with a three-stage, multiday, cascade impactor. This unit segregates particulates by three size stages and has been installed to operate on a continuous 7-day-per-week basis. The cascade impactor also is part of an evaluation study to enable the EMSL-LV to assess the value of particle-size determinations in this and other programs. The samples are analyzed by the University of California at Davis. Additional information is contained in Appendix C.

Timers

Two stations, at Lee's Ferry, AZ, and Chaco Canyon, NM, are equipped with 24-hr timers. Both stations are operated by personnel of the National Park Service, for whose convenience the timers are provided to start and stop the sampling equipment. The timers relieve the National Park Service personnel of the need to be physically present at the monitoring station for the beginning and end of the sampling period.

Electrical Generators

Three stations, located at Bodaway, AZ, at Tsa Schizzi, AZ, and at Burnham, NM, have no commercial electrical power available and are equipped with propane-powered electrical generators.

The generators are installed on the sampling towers at a height of 1.8 m (6 ft) above the ground to minimize the detrimental effects of sand and other materials that otherwise might be blown into the generators.

SECTION 5

FIELD OPERATIONS

COORDINATION AND DATA FLOW

The field office of Ute Research Laboratories in Blanding, UT, locally manages the program and the monitoring network. Personnel from this office maintain the equipment, calibrate the samplers, analyze the accumulated data, prepare reports, and assist and supervise the individual field operators.

As shown in the data flow chart of Appendix A, all samples collected by the field operators at the monitoring stations are sent to the field office in Blanding. The samples are sealed in folders, on which are recorded the field operator's observations on the types of winds encountered, precipitation, and visibility. The data on the folder are recorded in bound notebooks at the Blanding office, and the samples then are transmitted to Ft. Duchesne for analysis.

The Ute Research Laboratories' facility at Ft. Duchesne, UT, performs the actual laboratory analyses of the collected samples, processing them in the manner described in later sections of this report. Once the samples have been analyzed, the laboratory results and any remaining portions of the sample filters are returned to the field office in Blanding which performs the required calculations and prepares Storage and Retrieval of Aerometric Data (SAROAD) forms for submission to the EMSL-LV. The quarterly and annual reports on the program are initiated at the Blanding field office and submitted to the EMSL-LV.

FIELD OPERATORS

Most of the field operators used in this program had prior training and experience in performing the tasks required to operate the monitoring stations. In a few cases, new operators had to be trained in the operation of newly implemented monitoring stations.

Each operator is responsible for the proper conduct of scheduled procedures at a preassigned station. Each station is assigned to its own operator to minimize variations that otherwise might result from individual differences in the way observations are made and recorded.

For the stations not equipped with timers, the operator travels to the site on the morning of the day on which the 24-hr sampling period begins. The operator inspects the equipment, making sure that all equipment is properly

operational, installs the appropriate filter(s) in the sampler(s), installs a new chart on the flow recorder (used with the high-volume sampler), and starts the sampler(s). At the start of the sampling period, the operator records the beginning flow rate(s) for the sampler(s), the filter number(s) used, the time of day, the date, the location, and his observations on the condition of the equipment and filter(s). This information is recorded on the folder(s) used to send the filter(s) to the field office.

At the end of the sampling period, the field operator records the final flow rate(s) for the sampler(s). The operator also completes a simple weather report for the previous 24 hr, including the types of winds encountered, the precipitation (if any), and the visibility; these also are recorded on the folder(s) that will contain the sample(s). The operator then shuts off the sampling equipment, removes the filter(s), and places the filter(s) in the folder(s) on which the applicable data have been recorded. These folders then are mailed to the field office in Blanding.

Operators at the three sites having propane-powered electrical generators also are responsible for turning on the propane supply, checking the oil in the generator, and checking the condition of the starting battery. Before actuating the sampling equipment, the operator must start the generator and make certain it is functioning properly. At the end of the sampling period, the operator must turn off the generator, turn off the propane, and perform any required oil change (after every third sampling period; averaging once per week).

The operator at Henrieville, UT, also must perform tasks associated with the operation of the two-stage, high-volume air sampler and the three-stage, multiday, cascade impactor. These tasks include the installation of the appropriate filters and impaction drums. Furthermore, upon each visit to the station during the 7-day operating interval of the multiday impactor, the operator must check the device for proper time synchronization and operation, making any necessary adjustments and recording observed deviations.

As mentioned earlier, the stations at Lee's Ferry, AZ, and at Chaco Canyon, NM, are equipped with 24-hr timers. The operators of these stations need only inspect the equipment, install the filters, and set the timers. They may return at any time after the end of the sampling period to remove the filters and prepare the samples for transmission to the field office.

SAMPLING SCHEDULES

Between January, 1976, and April, 1977, there was no uniform sampling schedule in use. As a result, not all monitoring stations were in operation at any one time, although sampling was required for three 24-hr periods each week.

In April, 1977, uniform scheduling was implemented, requiring all operators to activate their stations during the same periods of time. A calendar is prepared in the Blanding field office each quarter, indicating the specific days on which every station is to be activated. Under normal circumstances, sampling is performed on even-numbered days, with adjustments for holidays, etc. This results in an average of three sampling periods per

week, and simultaneous sampling enables comparisons of all areas to be made at the same time. A sampling period normally starts between 7:00 and 10:00 a.m.

CALIBRATION AND MAINTENANCE

Routine calibration and preventive maintenance are performed on all sampling equipment by personnel from the Blanding field office at intervals of not more than 2 months. Should the operator encounter problems with the equipment or observe any conditions that might adversely affect the sampling, the operator contacts the field office immediately. Such problems are corrected as soon as possible (normally within 3 days) to assure continued and reliable monitoring. Every sampling unit is recalibrated immediately after repair.

SUPPLIES

Filters and other associated sampling supplies are routinely distributed to the field operators by the Blanding field office every 2 months. Before being distributed, filters are subjected to extensive quality assurance procedures, as described in a later section of this report. As a final check, operators are instructed to visually examine filters and supplies before use to verify that they are free from flaws and defects.

SECTION 6

ANALYTICAL PROCEDURES

OBJECTIVE

To establish the desired data base, it has been necessary to implement analytical procedures that accurately reflect the concentrations of the various pollutants in the samples obtained from the monitoring stations. Each sample is subjected to analysis by atomic absorption spectroscopy to determine the concentrations of trace metals. The specific metals of concern are cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), molybdenum (Mo), nickel (Ni), and iron (Fe).

In May, 1977, additional analyses were implemented to determine the presence and concentrations of sulfates and nitrates. The sulfates are analyzed by the methylthymol-blue colorimetric procedure, and the nitrates are analyzed by the copperized-cadmium reduction colorimetric procedure.

Throughout the monitoring and analytical procedures, strict quality assurance measures have been implemented to validate the sampling procedures, the analytical procedures, and the final results obtained.

FILTER CONTROL

Upon receipt from the supplier and prior to distribution to the field operators, each filter is subjected to rigorous quality checks to assure that it is free of any flaws that might influence the samples obtained or their subsequent analyses. Any filters found to contain flaws are rejected.

Filter Storage

Each filter received from the supplier is prenumbered. The numbers are recorded and used throughout the sampling and analytical procedures to identify the particular filter and sample. The filters are stored in the balance room for a minimum of 48 hr before inspection and weighing. The balance room is maintained at a constant temperature of 21.1°C $\pm$ 1.1°C (70°F $\pm$ 2°F). The relative humidity in the balance room is recorded continuously, with filter weighings being performed only when the relative humidity is between 20% and 45%; the nominal humidity in the balance room is 20%.

No filter weighing is performed at a relative humidity greater than 45%; the possible influence of atmospheric water vapor is considered too great to allow proper determination of sample weights. At a relative humidity lower

than 20%, the filters are subject to accumulation of static electric charges that also constitute an interference.

Visual Filter Inspection

Each filter is examined on a light table. In this examination, the filters are checked for creases, holes, thin spots, excessively large glass particles, inclusions that might be impurities, and any other flaws that might adversely affect the sampling and analytical procedures. Any visible flaw causes the filter to be rejected.

Filter Weighing

The acceptable filters are individually weighed on an analytical balance which is calibrated prior to each session with a set of Class "S" weights. The number and weight of each "unexposed" filter are recorded in a bound notebook for later use in determining the actual sample weight from the difference between the exposed and unexposed weights.

Every tenth filter is reweighed by a second technician. If a difference of more than 1.0 milligram (mg) is found between the weights determined by the two technicians, all of the filters within $\pm$10 filters of the questionable measurement are reweighed. All reweighings are reflected in the recorded data for the filters.

Every 50th filter is pulled from the stock of acceptable filters. These are used in the quality assurance procedure as unexposed control filters for the laboratory analyses. Unexposed filter concentrations are used during the calculations of the metal, sulfate, and nitrate concentrations.

SAMPLE WEIGHING

When the exposed filters containing the air pollutant samples are returned to the Ft. Duchesne laboratory facility, they are conditioned in the balance room for 48 hr. The conditioning period allows the filters to stabilize at a close approximation of the temperature and humidity conditions under which they were weighed in their unexposed state. The procedures used during this second weighing are the same as those used in the original weighing.

After conditioning, the exposed filters are weighed again on the analytical balance, and the new weights are recorded in the bound notebook. The weight difference between the unexposed and exposed weighings for any given filter is a measure of the weight of the particulates captured during the sampling period. In nearly all cases, particulate concentration is not sufficient to form a "cake" on the filter that might be subject to loss of collected material in the handling process. A few filters with large amounts of collected particulates have shown some settling of the materials into the fold in the filter, but, in most cases, the particulates appear to be impacted firmly onto the filters.

TRACE-METAL ANALYSIS

The analysis for trace metals is accomplished by means of atomic absorption spectroscopy. The atomic absorption spectrometer is a standard, commercial instrument, and the techniques for sample preparation are standard methods requiring the preparation of an extract from a portion of the exposed filter. The atomic absorption spectroscopy analysis is not applied to an entire filter and its sample, but to only a portion of the filter. As a result, the analysis determines the concentration of a given trace metal in a filter segment. This value is related to the total concentration on the filter by a simple proportion. The filter concentration value then is adjusted for the filter background and divided by the volume of air that was passed through the filter, yielding an average 24-hr ambient air concentration for the trace metal.

Filter Preparation

Since only a portion of the total particulate sample is used for the trace-metal analysis, a section of filter material, with its captured sample, must be removed from the whole filter. This is accomplished with a sharp-edged instrument and a plastic template that serves as a cutting guide and assures a uniform sample size. Every effort is made to cut the samples from the same areas of the individual filters.

For high-volume filter samples collected prior to July 1, 1977, filter strips measuring approximately 51 by 203 mm (2 by 8 in) were cut from the filters for use in the refluxing procedure. Samples collected after that date are subjected to a revised refluxing procedure described later in this section and use filter strips measuring 19 by 203 mm (0.75 by 8 in).

For the round filters used in the low-volume air samplers, half of the filter is used in the refluxing procedure. This is a semicircular section having a radius of 51 mm (2 in).

For the two-stage, high-volume air sampler, the second-stage filter is treated identically to those from the regular high-volume samplers. The 76- by 127-mm (3- by 5-in) first-stage filter is cut to obtain a 38- by 127-mm (1.5- by 5-in) strip perpendicular to the slits in the filter.

Refluxing Procedure

The refluxing procedure is the method by which samples are prepared for analysis with the atomic absorption spectrometer (Thompson et. al, 1970). This procedure consists of extracting the sampled material from a portion of the filter and concentrating the extract to a point suitable for use in the spectrometer.

Sample preparation is the single most important aspect in the analysis of trace metals contained in airborne particulates. Extreme care is exercised in the process of preparing samples to prevent any loss or contamination of the samples.

Contamination Safeguards--

To prevent contamination of a sample, certain safeguards are incorporated into the refluxing procedure. These safeguards prevent residual metals from entering the sample as a result of glassware contamination and impurities in the chemical reagents.

Before use, all glassware used in the refluxing procedure is cleaned thoroughly by soaking for a period of 2 to 6 hr in 20% (by volume) nitric acid (HNO_3). Then, the glassware is rinsed thoroughly with redistilled water to assure the removal of all metals.

The HNO_3 and hydrochloric acid (HCl) used in the refluxing procedure are distilled in an all-glass still to assure the removal of any metal contaminants that might be present in the solutions.

Unexposed glass filters from each filter lot are subjected to the refluxing and analysis procedure along with the actual samples. The resultant data provide a measure of the metals content of the filters themselves. Those data then can be applied to the results for the actual samples from filters of that lot to compensate for the influence of the filter itself.

Sample Extraction--

Each filter section subject to the refluxing procedure is placed in a glass thimble, which, in turn, is placed in an extraction tube. A 125-milliliter (ml) Erlenmeyer flask having a 24/40 female joint then is charged with 8 ml of constant boiling, 19% (approximate by volume) HCl and 32 ml of 40% (by volume) HNO_3. The extraction tube containing the filter sample is attached to the flask and then is fitted with a condenser.

The acid solution is maintained at its boiling point of 110°C to 115°C (230°F to 239°F) by the heat from a large electric hot plate. For a 3-hr period, the acid solution is refluxed over the filter sample, extracting the metals from the sample. Throughout the entire extraction process, the filter sample and the glass thimble remain at the temperature of the boiling acid solution.

Sample Concentration--

At the end of the 3-hr refluxing period, the extraction tube and condenser are removed from the flask. The flask then contains the acid solution with the metals extracted from the sample, and it is boiled on a hot plate until only 1 to 2 ml of concentrated extract remains. This concentrate then is allowed to stand and cool overnight.

When the concentrate has cooled, it is transferred quantitatively to a graduated 15-ml centrifuge tube. The transfer includes washing the flask three times, each time with 5 to 10 drops of the same type of solution used in the refluxing. Then, the sample is centrifuged for 30 minutes (min) at 21 radians per second (rad/s) (200 revolutions per minute). After having been centrifuged, the supernatant liquid is decanted into a polypropylene tube suitable for use in the spectrometer. The volume of each tube is brought up to 10 ml by the addition of a sufficient volume of 19% HCl.

At this point, the sample is ready for analysis by atomic absorption spectroscopy. The polypropylene tubes are sealed immediately with a thin plastic film to prevent contamination. Although the samples may be stored for 24 hr before they begin to deteriorate, they are analyzed the same day that they are centrifuged.

As a result of the special study described in Section 8, the extraction procedure outlined above has been replaced with a simpler and more reliable procedure. For all samples collected after July 1, 1977, the revised refluxing procedure was used.

Under the new procedure, each filter section is placed in a 50-ml beaker and immersed in 15 ml of 10% HNO_3. The beaker then is covered with a watchglass and heated to a gentle boil. After boiling for about 30 min, the solution is allowed to cool. The extract solution then is filtered though a 20-mm square of tissue, and the filter strip is washed with three 5-ml portions of HNO_3. These washings and the extract solution are combined in a 25-ml volumetric flask and diluted to volume with 10% HNO_3. At this point, the sample is ready for analysis.

Spectroscopic Analysis

After the samples have been prepared by the refluxing procedure, the entire sample batch is analyzed by atomic absorption spectroscopy. This analysis determines the presence and relative concentrations of cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, and iron in each of the samples. The concentration of each trace metal in each sample is determined by comparing the atomic absorption of the sample solution to that of standard metal solutions containing known concentrations. The standard solutions are prepared in the laboratory using spectroscopic-grade reagents and standard laboratory methods.

The Ute Research Laboratories' facility prepares the working spectroscopic standard solutions for each day that the analyses are performed. The working solutions are prepared from a stock solution, containing from 0.5 to 1.0 milligrams per milliliter (mg/ml) of each metal. The metal concentrations of the working standard solutions vary with the sensitivity of the spectrometer and the detection limits for the particular metals.

Spectroscopic Interferences

Interferences that may affect the spectroscopic analyses are well defined in the existing literature, and they may include spectral, chemical, and ionization interferences. In nearly all cases, these interferences can be overcome, or their effects minimized, by matching the matrices of the standard solutions to those of the individual samples.

The most significant interference encountered in analyzing glass-fiber extracts can be attributed to large amounts of dissolved solids present in the solution to be analyzed. The effect of this interference is overcome by using sample dilution to decrease the dissolved solids content to less than 0.5% by volume.

Another interference results from silica present in the sample extracts. This silica content results from the action of the refluxing procedure on the glass fibers of the filters and on the sample of particulate matter. The presence of silica interferes with the analyses of calcium, iron, manganese, and zinc. Of these elements subject to silica interference, iron and manganese are included in the required analyses. To overcome the effect of silica in the samples, the refluxed concentrate is allowed to stand for 12 to 24 hr and then is centrifuged. Decanting then separates the acid extract from the silica prior to spectroscopic analysis.

SULFATE AND NITRATE ANALYSES

The analyses for sulfates and nitrates are accomplished with the methylthymol-blue and copperized-cadmium reduction colorimetric methods respectively. The analyses are performed by a standard Technicon Autoanalyzer™ , using standard dyes and reagents. Standard laboratory procedures are followed for the preparation of the sample extracts used in these analyses.

As in the trace-metal analysis, these procedures are not applied to an entire filter and its sample, but only to a portion of the filter. The concentration determined for the filter strip is corrected for filter background and is related to the entire filter by a simple proportion. The resulting value is divided by the volume of air sampled, giving a 24-hr average ambient air concentration.

Sample Preparation

The analyses for sulfates and nitrates require the preparation of a sample extract for use in the Technicon Autoanalyzer™ . To assure accuracy in the analytical procedures, these samples must be prepared carefully, with appropriate measures taken to avoid contamination. All glassware is cleaned thoroughly before use and then rinsed thoroughly with distilled, deionized water. Prepared samples are stored in sealed, polyethylene bottles that also have been cleaned and rinsed to prevent contamination by sulfate and nitrate residues. Unexposed glass-fiber filters from each filter lot are subjected to the extraction and analysis procedures along with the actual samples to measure the presence of any sulfate or nitrate contamination in the filters themselves.

Filter Preparation--

Since only a portion of the total particulate sample is used for the sulfate and nitrate analyses, a section of the filter material, with its captured sample, must be removed from the whole filter. This is accomplished with a sharp-edged instrument and a plastic template that serves as a cutting guide. Every effort is made to cut the samples from similar areas of the individual filters.

For a round filter from a low-volume air sampler, the second half of the filter is used; the first half was used in the trace-metal analysis. This is a semicircular section having a radius of 51 mm (2 in). For a 203- by 254-mm (8- by 10-in) rectangular filter from a high-volume air sampler, a strip

measuring 19 by 203 mm (0.75 by 8 in) is cut from the filter adjacent to the strip removed for the trace-metal analysis.

For the two-stage, high-volume air sampler, the second stage filter is treated identically to the filter from a regular high-volume sampler. The first-stage filter is cut to obtain a 38- by 127-mm (1.5- by 1.5-in) strip that crosses the slits in the filter.

Sample Extraction--

Each filter section is placed in a 125-ml Erlenmeyer flask having a 24/40 female joint. The flask then is charged with 35 ml of distilled, deionized water, and a condenser is connected to the flask opening. The contents of the flask are boiled gently for 1 hr and then allowed to cool to room temperature.

When cool, the condenser is rinsed twice into the flask with distilled, deionized water. The contents of the flask are filtered through a fritted glass Buchner funnel, washing the funnel twice with water. The collected filtrate is brought to a total volume of 50 ml with distilled, deionized water, and the contents then are transferred to a polyethylene bottle for storage until sufficient samples have been prepared for analysis.

Each analysis sequence takes place after 60 samples have been prepared. Normally, this occurs every 2 days. The polyethylene bottles are sealed to prevent contamination during storage. Storage is at room temperature, and the 48-hr period required to accumulate the necessary 60 samples is not long enough to cause deterioration of the samples.

Nitrate Analysis

When 60 samples have been accumulated, the entire batch is analyzed with the Technicon Autoanalyzer™ . The Autoanalyzer™ is allowed to warm up for at least 1 hr before the analysis begins. The dyes and analytical standards, which are kept refrigerated, are allowed to reach room temperature before use.

When the proper dyes and reagents have been placed in the Autoanalyzer™ the instrument is calibrated. Calibration is accomplished by running a standard nitrate solution of 10 micrograms per milliliter (μg/ml) until a constant reading is obtained from the instrument. A full set of standard solutions then are run to obtain calibration curves for nitrate concentrations of 1.0, 2.0, 4.0, 5.0, 7.0, 8.0, and 10.0 μg/ml.

When the Autoanalyzer™ has been calibrated, sampling tubes for the instrument are charged with 10 ml of sample solution from each of the storage bottles. With every 10 samples, one control sample having a known concentration of 5.0 μg/ml is included. Every 10th sample has a second strip cut, extracted, and run as a duplicate, and a sample extracted from an unexposed filter is run every 50 samples.

The results from the Autoanalyzer™ for each of the samples are recorded on a strip-chart recorder. If any one of several deviations in the analysis occurs, the entire set of samples is rerun until the deviation is eliminated. The deviations causing the samples to be rerun include failure to indicate the

proper 5.0-μg/ml concentration for the control sample of known concentration, or the failure to obtain duplicated results for the duplicated extract samples.

Sulfate Analysis

The sulfate analysis procedure is the same as that for the nitrate analysis, including the calibration procedure, standard control samples, duplicated samples, and samples from unexposed filters. However, the reagents are changed to utilize the methylthymol-blue colorimetric method for sulfates instead of the copperized-cadmium reduction colorimetric method for nitrates. The Autoanalyzer™ is equipped with a commercial resin-base ion exchange column, and a linearizer is used on the chart recorder.

SECTION 7

DATA PROCESSING AND REPORTING

As described in Section 4, Ute Research Laboratories' field operators record the station name, the filter number, the starting and stopping times of day, the starting and stopping flow rates, the date, some brief weather information, and their comments for each sampling period. This information is recorded directly on the folder in which the sample filter and the flow-meter chart (high-volume sampler) are transmitted to the field office in Blanding, UT.

At the Blanding field office, the information from the folder is transcribed to bound notebooks. The average flow rate is calculated from the flow-meter chart (high-volume sampler) or from the magnehelic gauge readings (low-volume sampler) and the calibration graphs for the individual sampler. The average flow rate also is recorded in the bound notebook. The Blanding field office then transmits the folder and its filter to the Ft. Duchesne laboratory facility for analysis.

At Ft. Duchesne, the readings obtained for each sample from the atomic absorption spectrometer are recorded on consecutively numbered tables that then are bound together. This information, together with the unexposed and exposed filter weights and the results of the sulfate and nitrate analyses (from the Autoanalyzer™ strip charts), then is transcribed into a bound notebook and onto the folder containing the filter. The unused portions of the filters and their folders containing the data then are returned to the Blanding field office for final calculations and report preparation.

The Blanding field office uses a programmable printing calculator to complete the required calculations. The TSP and the concentrations of the various trace metals, sulfates, and nitrates are calculated from the analysis results and the average flow rates.

The results of these calculations are recorded on the filter folder and on SAROAD forms for submission to the EMSL-LV. One copy of the completed SAROAD form for each sample is retained by the Blanding field office as a permanent record. The printout from the calculator is retained with the folder for the filter, and all folders, filters, flow charts, and calculator printouts are stored permanently at the Blanding field office.

At the end of every quarter, the Blanding field office averages the data accumulated during that quarter for each monitoring station. All of the

quarterly data, including analysis results, calculated concentrations, etc., are incorporated into a quarterly report submitted to the EMSL-LV. The Blanding field office also prepares an annual report for the monitoring program and submits the report to the EMSL-LV.

SECTION 8

QUALITY ASSURANCE PROCEDURES

GENERAL DESCRIPTION

The quality assurance procedures implemented for this monitoring program can be divided into two categories--internal quality control and external quality assurance. The internal quality control measures consist of the procedures that have been implemented within Ute Research Laboratories for evaluating the accuracy and precision of the sampling procedures, analytical methods, data reporting, etc. The external quality assurance measures consist of participation in the Western Energy Quality Assurance Program, conducted by Rockwell International under a contract with the EPA.

INTERNAL QUALITY CONTROL

The internal quality control measures implemented by Ute Research Laboratories affect the monitoring procedure, the analysis methods, and the data calculations and reports. For the most part, these internal measures have relied upon standard techniques of performing various tasks and checking for repeatability of results obtained from duplicated procedures.

Filter Quality

Every filter is subjected to a thorough visual examination on a light table. Any filter found to have a crease, hole, thin spot, large glass particles, or inclusion of any kind is rejected and is not used for sample collection or for an unexposed control sample in the analytical procedures.

Filter Weights

Each filter is allowed to stabilize at a constantly maintained temperature and a known humidity before it is weighed (whether unexposed or exposed). If the relative humidity in the balance room is higher than 45% or lower than 20%, filters are not weighed on that day.

All weighings are performed on an analytical balance calibrated against a standard set of Class "S" weights to assure its accuracy. Ten percent of all filters that passed the visual inspection are first weighed by one technician and then reweighed by a different technician. If a difference of more than 1.0 mg is observed between the two weighings of the the same filter, all filters within ± 10 filters of the questionable weight are reweighed; in such a case, a total of 21 filters would be reweighed. Any problems or deficiencies

noted are corrected immediately. Table 2 summarizes a portion of a weighing sequence, indicating the results that are responsible for reweighing an entire filter sequence.

TABLE 2. SAMPLE OF DUPLICATE FILTER WEIGHINGS

Filter No.	1st Weight, grams	2nd Weight, grams	Filter No.	1st Weight, grams	2nd Weight, grams
1104103	4.1804	4.1811	1122463	3.9755	3.9747
1101385	4.0879	4.0877	1125250	4.2110	4.2110
1121922	4.1339	4.1336	1097226	4.0928	4.0929
1125100	4.2069	4.2065	1094659	4.0210	4.0213
1124029	4.1350*	4.1367*	1124449	3.9002	3.9000
1124084	4.0130	4.0128	1122415	4.2506*	4.2491*
1122354	4.1105	4.1100	1089489	4.3166	4.3159
1127042	4.2783	4.2779	1107452	4.0608	4.0608
1123070	3.9527	3.9520	1112297	4.2369	4.2366
1126126	3.9475	3.9471	1111285	3.9943	3.9941

* denotes duplicated filter weighings not within 1.0 mg; 21 filters within ±10 filters of these were reweighed.

Monitoring Equipment

Field operators are responsible for a thorough inspection of the samplers and associated monitoring equipment at the start of every sampling period. Deficiencies are reported immediately to the Blanding field office for correction. Personnel from the Blanding field office routinely perform preventive maintenance and complete recalibration of each sampler at intervals not exceeding two calendar months. Whenever a sampler is repaired, it is recalibrated before being returned to operation.

Laboratory Facility

The Ft. Duchesne laboratory facility routinely follows specific quality control procedures governing the water the chemical reagents used, duplication of samples, use of control samples, and calibration of equipment.

Laboratory Water and Reagents--

All water used in the analytical procedures is distilled and deionized. A daily check of the electrical conductivity is made to assure the water quality; if a rise in the electrical conductivity is noted, the deionization tank is changed immediately.

All laboratory reagents are stored in accordance with standard procedures to prevent deterioration of the chemicals or any form of contamination. Dyes and reagents for the sulfate and nitrate analyses are kept under refrigeration. Acids used in the trace-metal analysis are distilled in all-glass stills to assure freedom from metallic contamination; the water used to dilute these acids also is redistilled in an all-glass still.

All samples subject to storage are sealed and protected from contamination.

Trace-Metal Analysis--

The analysis of the samples for trace metals has been and continues to be an area of major concern for quality control. Ute Research Laboratories established routines designed to prevent contamination of the samples by metallic compounds from outside sources, including distilling acids in an all-glass still, redistilling water in an all-glass still, meticulous cleaning and rinsing of all glassware used in the process, and refluxing and analyzing unexposed control filters for any background trace metals that might contribute erroneous data.

As a quality control check, duplicate analysis of 10% of the filter samples was implemented, with the results from the two analyses being compared for repeatability. Despite all safeguards incorporated into the procedure, the duplicate analyses showed poor reproducibility in some of the results. Further checks performed by an outside laboratory, as described later in this section, also indicated a reproducibility problem. Table 3 lists a portion of the duplicate data; near the beginning of the table, some of the data show a fair level of agreement and repeatability, but other values show a wide scattering of the data obtained.

Overall, the duplicate data obtained for the trace-metal analyses were not good. Preliminary results indicated that extraction and refluxing procedures may have been at fault. Additional information on this problem and its resolution is included in the external quality assurance portion of this section.

TABLE 3. SAMPLE OF DUPLICATE TRACE-METAL ANALYSES

Filter No.	Cd*	Cr*	Co*	Cu*	Pb*	Mn*	Ni*	Mo*	Fe*
1101299	0.01	0.10	0	3.49	0.60	0.51	0	0	30.8
	0	0.08	0	2.34	0.50	0.52	0.10	0	25.0
1103643	0.03	0.18	0.10	2.16	0.15	3.90	0.12	0	154.0
	0.01	0.10	0.10	1.64	0.40	3.86	0.15	0	166.0
1103642	0	0.12	0	10.80	0.60	0.30	0.07	0	16.5
	0	0.02	0	2.30	0.20	0.16	0	0	13.0
1111948	0	0	0	0.10	0	0	0	0	2.65
	0	0.02	0	0.25	0.10	0.07	0	0	2.60
1089005	0	0.20	0	1.48	0.80	0.77	0.07	0	51.0
	0.01	0.06	0	0.67	0.20	0.52	0.10	0	26.0
1112488	0.06	0	0	0.37	0.20	0.94	0	0	45.0
	0.04	0.34	0	0.25	0.30	0.85	0	0	46.0
1103444	0	0.11	0	9.90	1.30	0.56	0	0	40.0
	0.01	0	0	2.30	0.40	0.33	0	0	18.0

* Concentrations are expressed in µg/ml.

Sulfate and Nitrate Analyses--

The quality control aspects of the analyses for sulfates and nitrates have been considerably less of a problem than those for the trace-metal analysis. Again, routine preventive measures are in effect, including the use of distilled, deionized water, meticulous cleaning and rinsing of glassware, sealing of samples while being stored for analysis, and other normal laboratory techniques.

Additionally, the Technicon Autoanalyzer™ used in these procedures is fully calibrated immediately prior to each use, utilizing standard control samples having a known concentration of sulfates or nitrates. The quality control procedure also requires that 10% of the samples be subjected to duplicate analyses, and that 2% of the analyzed samples be taken from unexposed filters to assess the effects of any sulfate or nitrate residues in the blank filters.

As a further check of the procedures and techniques, samples were acquired from the EPA in Research Triangle Park, NC, and their analyses were compared with those obtained from the same samples by Ute Research Laboratories.

Table 4 summarizes some of the results obtained from the duplicate analyses of samples taken from the same filter. Table 5 compares the Ute Research Laboratories' analyses of samples obtained from the EPA with the EPA's own analyses. Overall, the results show good agreement, with a good level of repeatability. However, no standards have been established for the rejection of any set of samples. Most results show less than a 5% difference between the duplicate analyses, and Ute Research Laboratories presently is

attempting to establish a set of standards and criteria for rejecting a set of sulfate or nitrate analyses.

TABLE 4. SAMPLE OF DUPLICATE SULFATE/NITRATE ANALYSES

Filter No.	Initial Analyses		Duplicated Analyses	
	Sulfates*	Nitrates*	Sulfates*	Nitrates*
1105391	15.5	3.1	14.7	2.9
1-911	15.8	1.0	15.8	0.9
1112240	8.5	2.1	8.5	2.2
1102627	6.6	2.7	6.5	2.6
1103430	7.0	4.9	6.9	4.5
1103631	8.4	5.2	8.4	3.7
1102688	11.3	2.6	10.1	2.9
1102612	9.8	1.8	10.0	2.0
1088692	7.5	2.2	7.8	2.3
1105333	7.6	6.3	7.7	6.6
1105351	6.1	0.8	8.3	1.0
1105334	9.2	4.1	9.2	4.1
1103470	12.3	1.2	10.8	1.1
1103466	15.6	1.4	13.3	1.4
1103462	15.1	0.8	15.2	0.8
1088514	8.0	1.7	7.8	1.7
1088618	13.6	2.4	14.3	2.6
1125243	17.3	8.5	16.2	7.9
1103741	6.3	3.9	6.4	3.8

* All concentrations are expressed in µg/ml.

TABLE 5. SULFATE/NITRATE ANALYSES OF EPA SAMPLES

Sample No.	Ute Research Values		EPA Values	
	Sulfates*	Nitrates*	Sulfates*	Nitrates*
2161	6500	1000	6550	1035
0261	3820	1895	3588	1878
2111	6720	1000	6550	1035
3180	7.6	0	0	0
5284	2550	810	2400	850
8276	1440	620	1400	700
5088	2450	795	2400	850
2169	6350	1030	6300	1000
1118	280	20	250	10
1199	250	95	200	91

* All concentrations are expressed in µg per strip.

Data Processing and Reporting

At all stages in the processing, recording, and reporting of data, all data are checked and rechecked for accuracy. Extreme care is taken at all stages to avoid erroneously reporting data until the checks and rechecks have been completed.

EXTERNAL QUALITY ASSURANCE

In addition to the internal quality control program implemented by Ute Research Laboratories, an external quality assurance program has been implemented with the assistance of Rockwell International. This program was necessitated by the need for validation of the Ute Research Laboratories' and other Western Laboratories' procedures in terms of accuracy.

The external quality assurance program began with a thorough audit of the Ute Research Laboratories' facilities and procedures by Rockwell International, and it continues with periodic "spot checks" of the procedures and ongoing studies of areas that have been found to be subject to particular difficulties. In many instances, recommendations made by Rockwell International for improvement of the procedures were incorporated immediately, while, in other instances, both Rockwell International and Ute Research Laboratories are participating in continuing studies of the problems prior to implementing revised procedures.

The external quality assurance program concentrates on the filter weighings, the air sampler calibration, the trace-metal analysis procedures, and the sulfate and nitrate analyses. Each is described in the following paragraphs.

Filter Weights

Every 6 months, Rockwell International provides Ute Research Laboratories with a set of standard weights for checking the analytical balance. In the first semiannual weight performance survey performed in March, 1977, the weights determined by the Ute Research Laboratories' analytical balance showed a significant difference from the weights obtained by Rockwell International. For all three standard weights, the Ute Research Laboratories' readings were approximately 2.5 mg less than those of Rockwell International. This was considered to be insufficient agreement, and appropriate adjustment of the balance was made. However, this consistent offset would cancel itself out, resulting in no error in the TSP values. Even if this were not the case, a 2.5-mg error would result in only a 1.5-$\mu g/m^3$ error in the reported TSP concentrations.

The analytical balance was checked and adjusted by the manufacturer's service representative to assure accurate, reliable, and repeatable performance. Ute Research Laboratories then obtained a set of standard Class "S" weights for checking and calibrating the balance; these weights are used prior to every weighing session to verify that the balance is adjusted properly.

In the second semiannual weight performance survey in November, 1977, an average daily difference of only 0.2 mg was observed between the readings obtained with the Ute Research Laboratories' balance and the readings obtained by Rockwell insternational. This is considered excellent agreement. Regular checking and calibrating of the balance with the Class "S" weights now is a routine part of the Ute Research Laboratories' procedures, and the semiannual weight performance surveys using Rockwell International's weights continue.

Air Sampler Calibration

On a semiannual basis, Rockwell International provides Ute Research Laboratories with a flow calibration kit containing a series of orifice plates. The equipment is mounted on one of the high-volume samplers, and measurements of the pressure drop across each plate and of the flow based upon a Ute Research Laboratories' flow meter are recorded. These values and the test equipment are returned to Rockwell International, where flows are computed and the flow values are compared.

In March, 1977, the first semiannual calibration survey indicated that Ute Research Laboratories' airflow measurements averaged 11% less than Rockwell International's measurements for the same sampler under the same conditions. This was stated to be a satisfactory but improvable level of agreement by Rockwell International.

In November, 1977, the second semiannual calibration survey indicated that Ute Research Laboratories' airflow measurements had improved to within 1.5% of Rockwell International's measurements for the same sampler under the same conditions. This was stated to be a very good level of agreement by Rockwell International.

Semiannual calibration surveys, using the flow calibration device furnished by Rockwell International, are a continuing and routine part of the overall quality assurance program for the monitoring network.

Trace-Metal Analysis

The analysis of the samples for trace metals has been and continues to be a subject of major concern in obtaining accurate and repeatable data.

A sampling of filter strips taken from the some of the filters collected by Ute Research Laboratories was sent to Rockwell International for comparative analysis using atomic absorption spectroscopy. The comparison of the analyses performed by the two laboratories showed a poor level of agreement.

To identify the source of the problem, Rockwell International prepared some sample solutions that were analyzed at their own facility and at the Ute Research Laboratories' facility. Rockwell International also prepared some filters containing metals to simulate the exposed filters collected from the monitoring network. The filters were subjected to the complete extraction, sample preparation, and analysis procedures by both Rockwell International and Ute Research Laboratories.

In comparing the results of the analyses, a good level of agreement was evident, indicating that the problem was not in the use of the spectrometer. However, a poor level of agreement still was evident when the prepared filters were subjected to the complete extaction, sample preparation, and analysis procedures. The source of the problem has been identified as being in the extraction and sample preparation procedures. On Rockwell International's recommendation, a change in the extraction procedure was implemented for all samples collected after July 1, 1977, and the revised procedure is outlined in Section 6.

Sulfate and Nitrate Analyses

On a quarterly basis, Rockwell International prepares filters with sulfate and nitrate compounds to evaluate the quality of the analyses. Five or six strips from the various filters are analyzed by Ute Research Laboratories. Meanwhile, Rockwell International analyzes 10 strips from each filter and determines a mean that then may be used for a comparison of the analyses.

The objective is for the Ute Research Laboratories' analyses to be within a target range established by Rockwell International. Rockwell International then plots the data from its analyses against the Ute Research Laboratories' analyses to determine a coefficient of linearity, as well as the slope and intercept of the best-fit straight line. The precision of the analyses is shown by the coefficients of linearity, which should approach unity ("1"). The accuracy of the data is shown by the slope of the best-fit straight line, which should approach unity ("1"), and by the intercept, which should approach zero ("0"). Extraction problems often are indicated by a slope that does not approach unity.

Table 6 summarizes the results of the sulfate analysis performance survey for two quarters (Ute Research Laboratories has participated in only the second and third quarter surveys in 1977). Rockwell International stated that the second quarter results were excellent, showing excellent slope, intercept, and coefficient of linearity. They reported that the third quarter results were good, having good slope and intercept with an excellent coefficient of linearity.

Table 7 summarizes the results of the nitrate analysis performance survey for the same two quarters. For the second quarter, the results show excellent data precision, as evidenced by the "1.000" coefficient of linearity. However, the slope is poor, and the actual values obtained are higher than expected, indicating poor data quality. The most probable cause of this defect has been traced to the use of a poor quality or contaminated standard solution in the Technicon Autoanalyzer™ . The results of the third quarter survey show a significant improvement and were rated as good by Rockwell International. The slope has improved considerably, while the coefficient of linearity remained good. These performance surveys are continuing on a quarterly basis.

TABLE 6. RESULTS OF THE SULFATE PERFORMANCE SURVEY

Survey Occurrence, 1977	Ute Value*, $\mu g/m^3$	Control Value†, $\mu g/m^3$	Target Range	Slope	Intercept	Coefficient of Linearity
2nd Quarter	0.12	0.09	0.05 - 0.14	1.0054	0.3327	0.9994
	2.58	2.44	2.14 - 2.74			
	3.42	3.18	2.93 - 3.43			
	7.56	6.97	6.07 - 7.87			
	7.92	6.97	6.07 - 7.87			
	27.12	26.82	18.67 - 24.97			
3rd Quarter	0.21	0.00	0.00 - 0.10	1.0418	0.1938	0.9987
	2.28	2.10	1.30 - 2.90			
	3.15	3.03	2.83 - 3.23			
	11.40	10.31	9.76 - 10.86			
	13.80	12.77	11.72 - 13.82			
	16.35	15.99	14.19 - 17.79			

* Values obtained by Ute Research Laboratories.

† Mean values obtained by Rockwell International.

TABLE 7. RESULTS OF THE NITRATE PERFORMANCE SURVEY

Survey Occurrence, 1977	Ute Value*, $\mu g/m^3$	Control Value†, $\mu g/m^3$	Target Range	Slope	Intercept	Coefficient of Linearity
2nd Quarter	0.00	0.01	0.00 - 0.03	1.3440	-0.0604	1.0000
	0.96	0.80	0.70 - 0.90			
	1.02	0.80	0.70 - 0.90			
	6.90	5.15	4.65 - 5.65			
	9.66	7.27	6.47 - 8.07			
	10.92	8.15	7.75 - 8.55			
3rd Quarter	0.08	0.00	0.00 - 0.10	0.9018	0.1910	0.9969
	0.75	0.72	0.57 - 0.87			
	1.45	1.30	1.10 - 1.50			
	4.54	4.67	4.12 - 5.22			
	5.77	5.85	5.65 - 6.05			
	6.66	7.54	6.74 - 8.34			

* Values obtained by Ute Research Laboratories.

† Mean values obtained by Rockwell International.

ON-GOING QUALITY ASSURANCE MEASURES

With the continuation of the monitoring program, all internal and external quality assurance measures are expected to continue, providing an increasing degree of confidence in the data being obtained. No problems have been noted as a result of the quality assurance measures that cannot be eliminated as the procedures are modified and refined.

At the time of this report, overall data collection and analysis has shown continuous improvement. Modifications to the procedures for analyzing the trace-metal content of collected samples have been implemented and are expected to eliminate significant problems with the program.

SECTION 9

SUMMARIZED DATA AND ANALYSES

This section graphically summarizes and analyzes the data obtained during this project from December, 1975, through February, 1977. Individual tabular summaries of the data for each of the monitoring stations are included in Appendix B. Values in this section are based on available data and may not represent statistically valid means. The validity of these means can best be evaluated using the information in Appendix B.

Figures 2 through 6 show the geometric mean values of TSP concentrations as measured at each of the monitoring stations during an individual season. Figure 2 compares all monitoring stations active during winter 1975-76, Figure 3 compares them for spring 1976, Figure 4 compares them for summer 1976, Figure 5 compares them for autumn 1976, and Figure 6 compares them for winter 1976-77.

Figures 7 through 30 utilize bar graphs to indicate the relationships between the geometric mean TSP concentrations for each individual monitoring station that was active during the data-collection period. In each figure, a broken line is used to indicate the overall geometric mean value for TSP concentrations.

As mentioned in Sections 6 and 8, the quality assurance program results indicate a problem with the trace-metal analysis procedures. The special cross checks suggest errors in accuracy of from 10% to 50%. Since the trace-metal data presented in this report were analyzed prior to the identification of this problem, the quality of these data is considered questionable. For this reason, no detailed analysis of trace-metal data is provided.

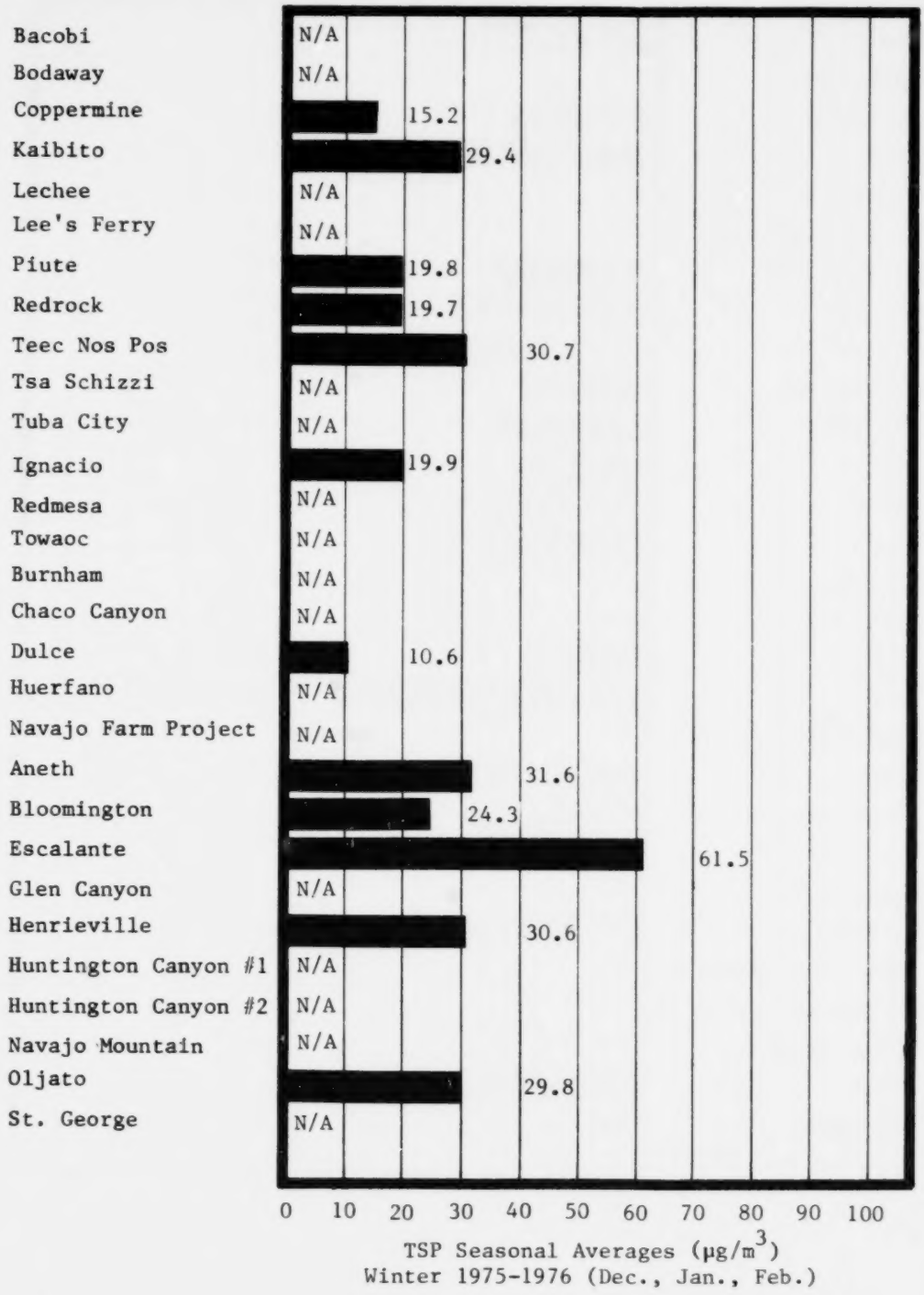


Figure 2. Winter 1975-76 seasonal TSP averages (all stations).

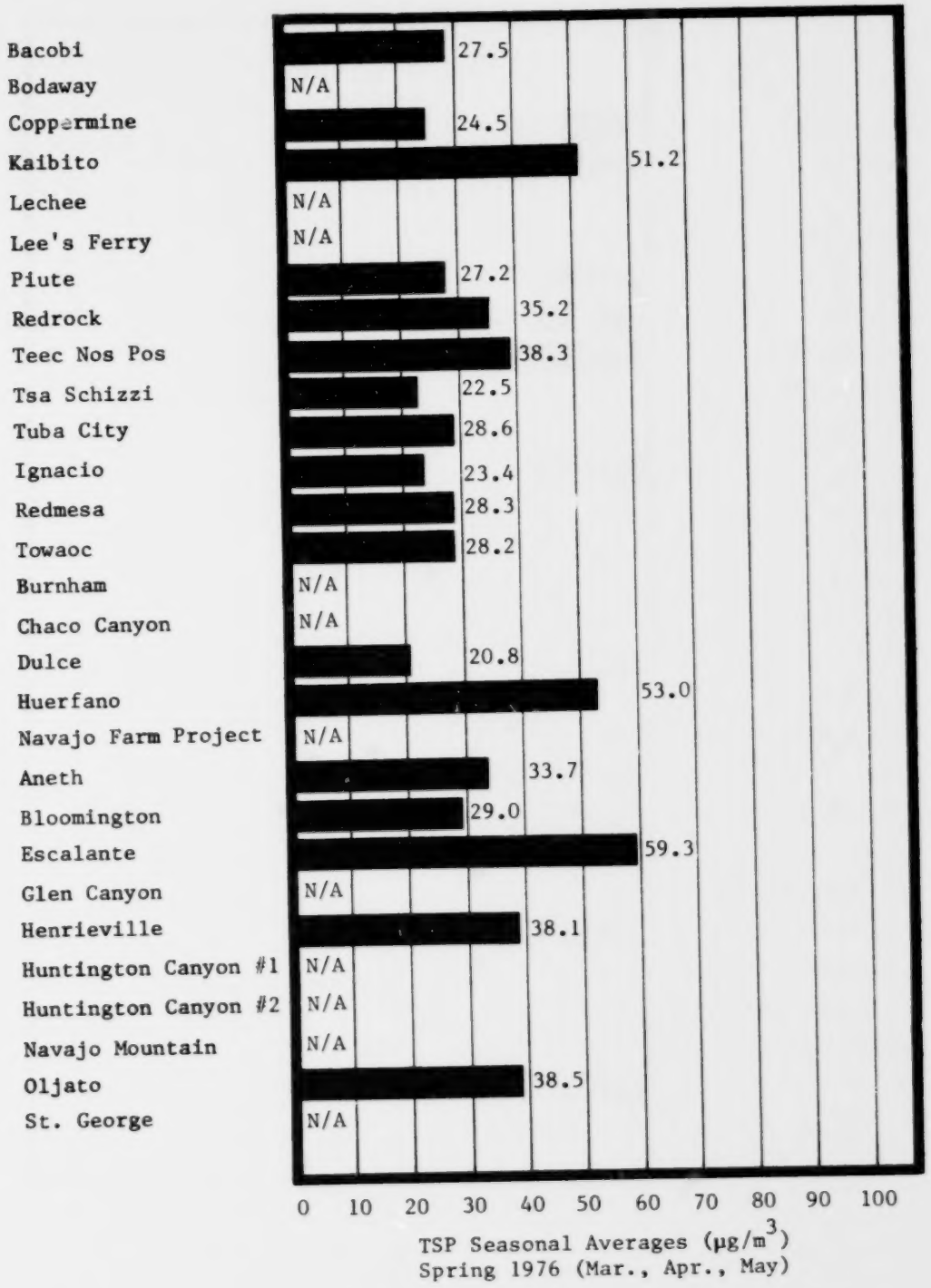


Figure 3. Spring 1976 seasonal TSP averages (all stations).

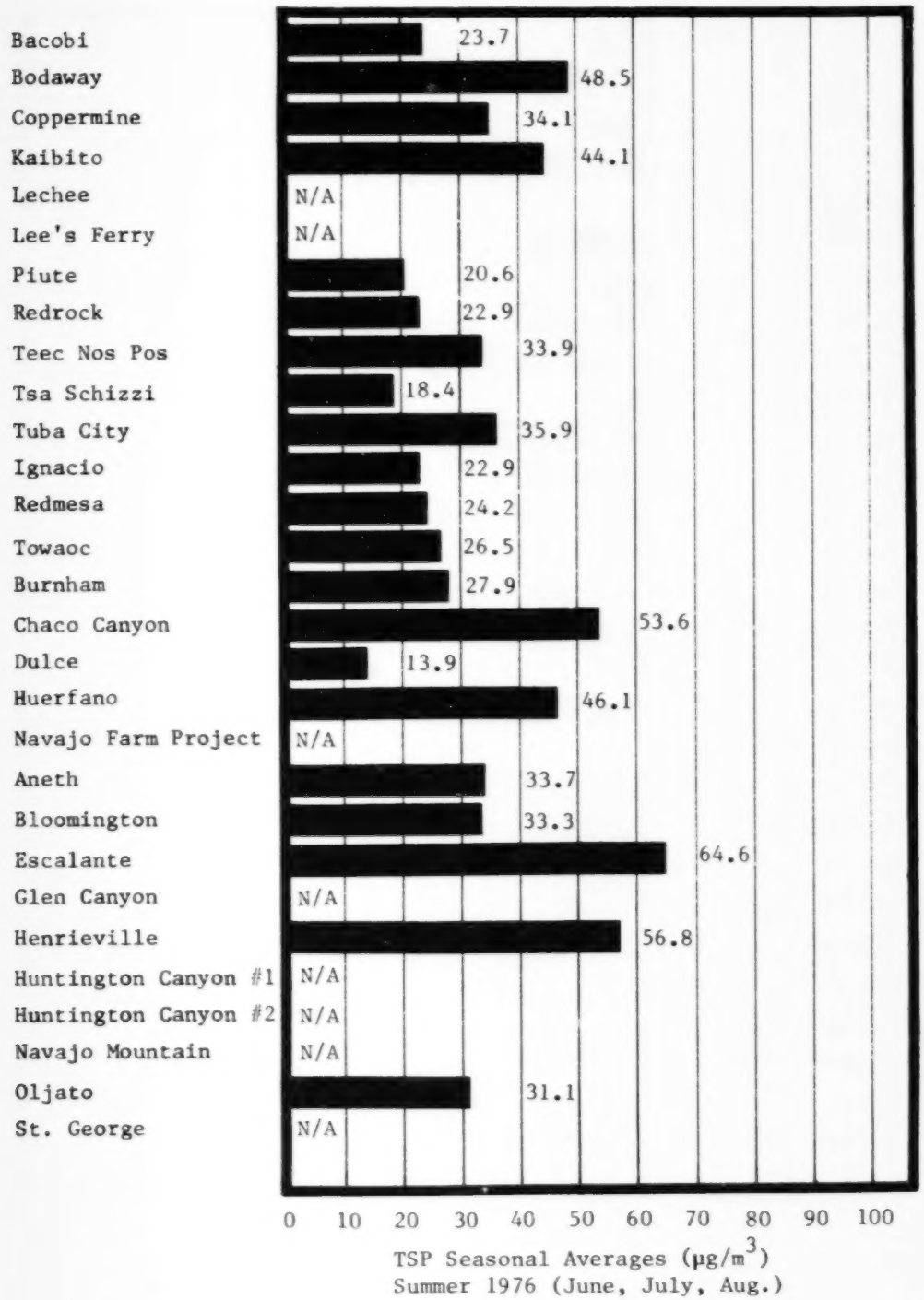


Figure 4. Summer 1976 seasonal TSP averages (all stations).

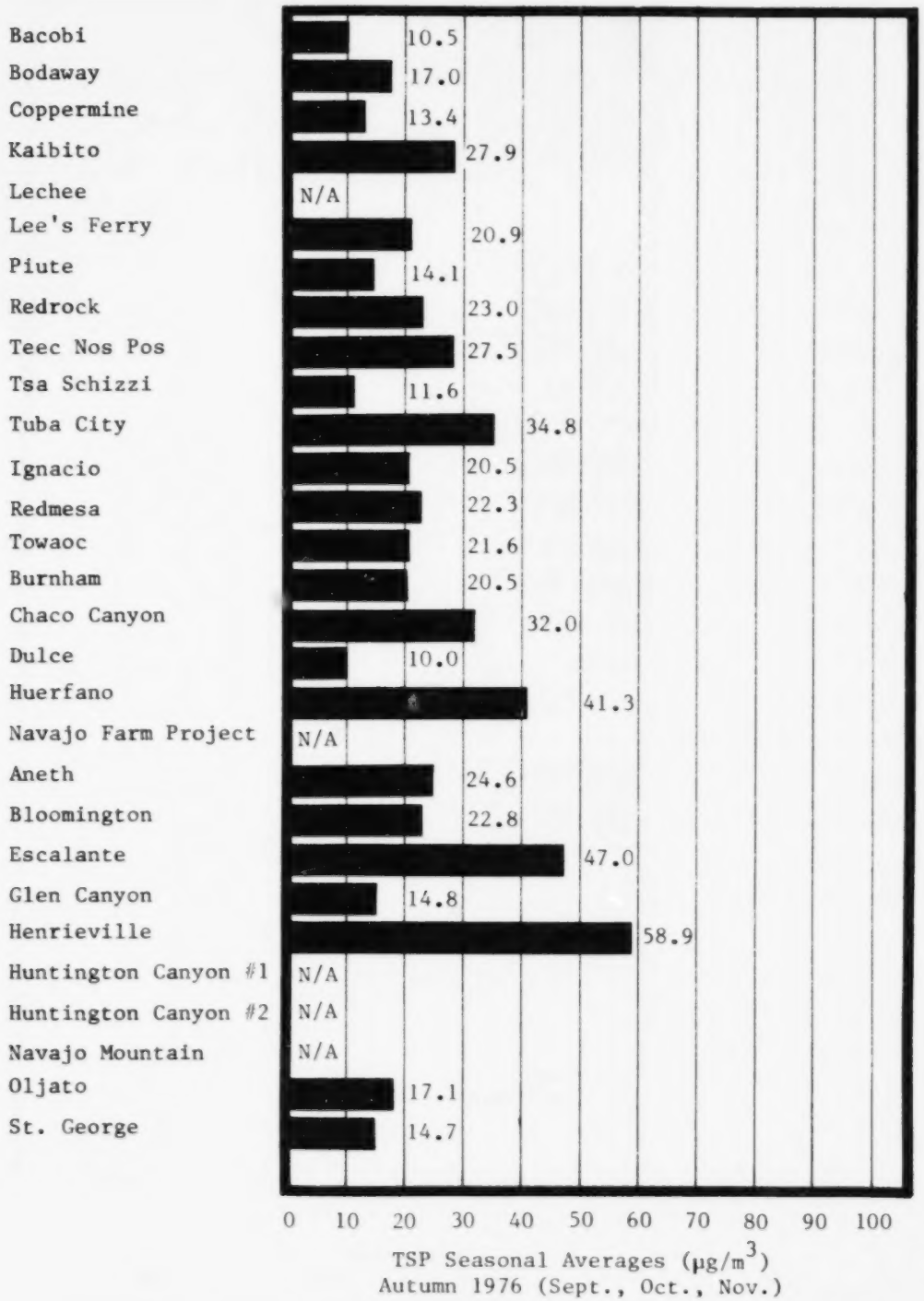


Figure 5. Autumn 1976 seasonal TSP averages (all stations).

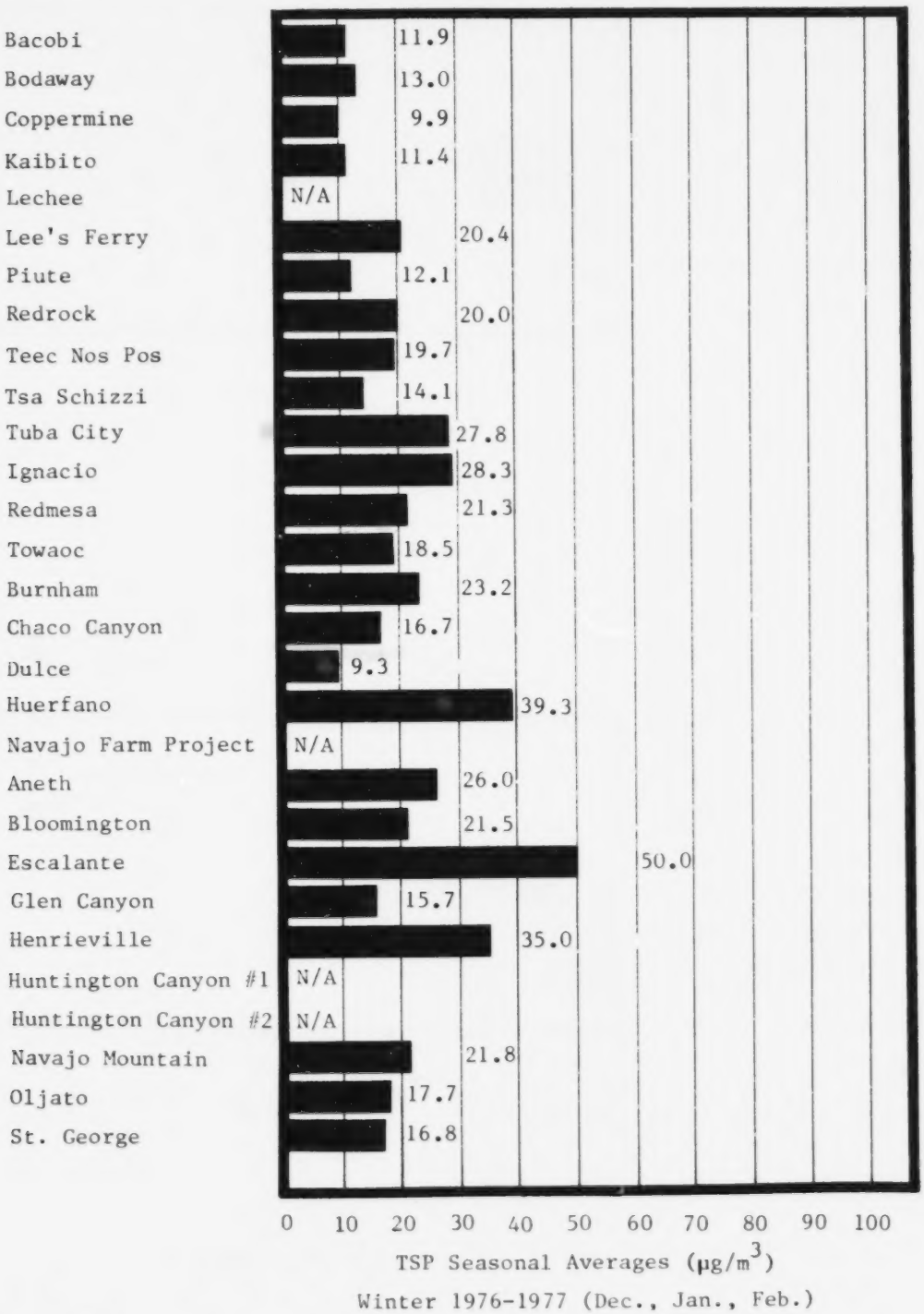


Figure 6. Winter 1976-77 seasonal TSP averages (all stations).

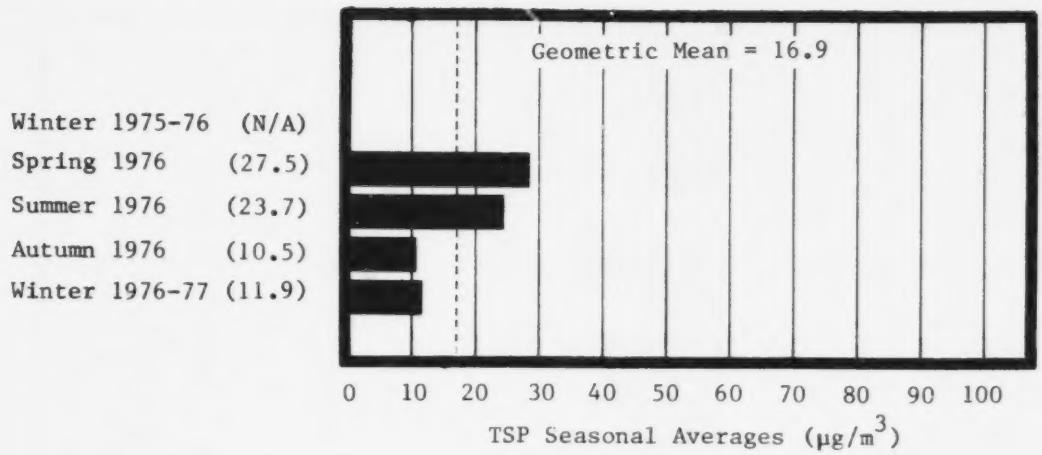

Geometric Mean = 16.9
Winter 1975-76 (N/A)
Spring 1976 (27.5)
Summer 1976 (23.7)
Autumn 1976 (10.5)
Winter 1976-77 (11.9)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (μg/m3)

Figure 7. Bacobi, AZ, seasonal TSP averages.

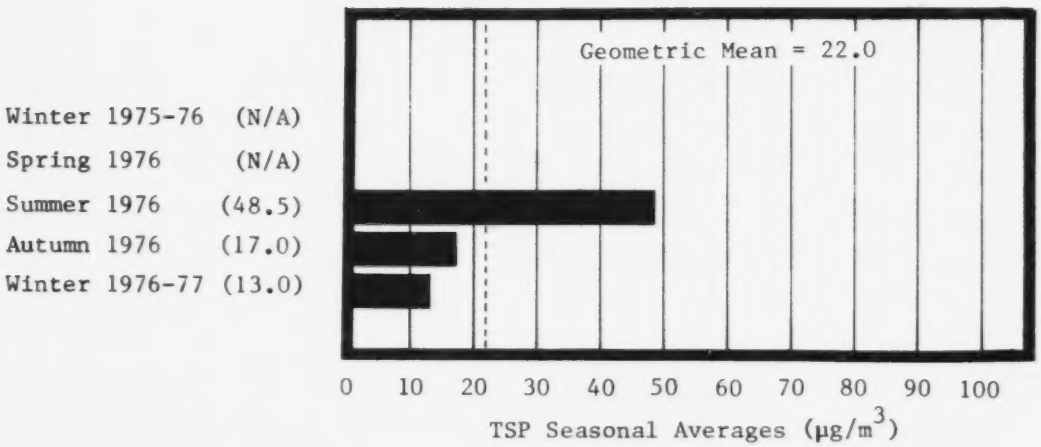

Geometric Mean = 22.0
Winter 1975-76 (N/A)
Spring 1976 (N/A)
Summer 1976 (48.5)
Autumn 1976 (17.0)
Winter 1976-77 (13.0)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (μg/m3)

Figure 8. Bodaway, AZ, seasonal TSP averages.

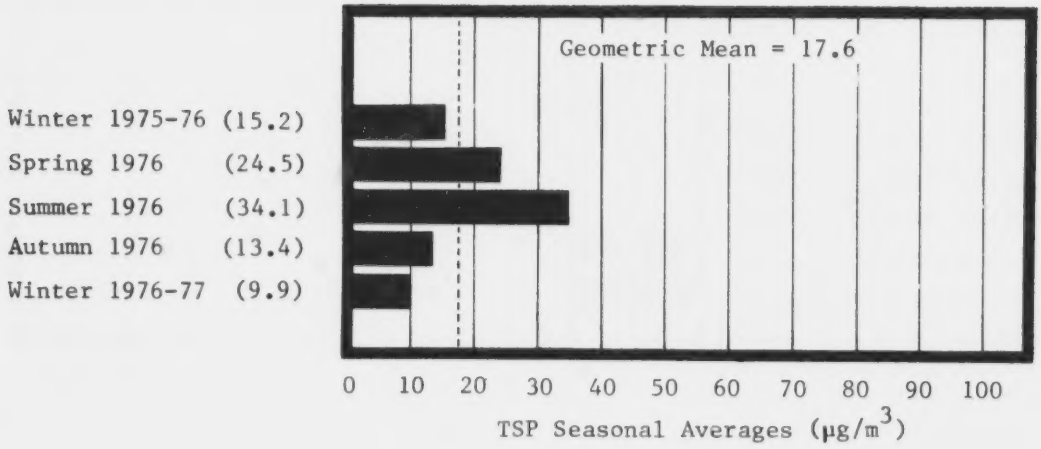

Geometric Mean = 17.6
Winter 1975-76 (15.2)
Spring 1976 (24.5)
Summer 1976 (34.1)
Autumn 1976 (13.4)
Winter 1976-77 (9.9)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 9. Coppermine, AZ, seasonal TSP averages.

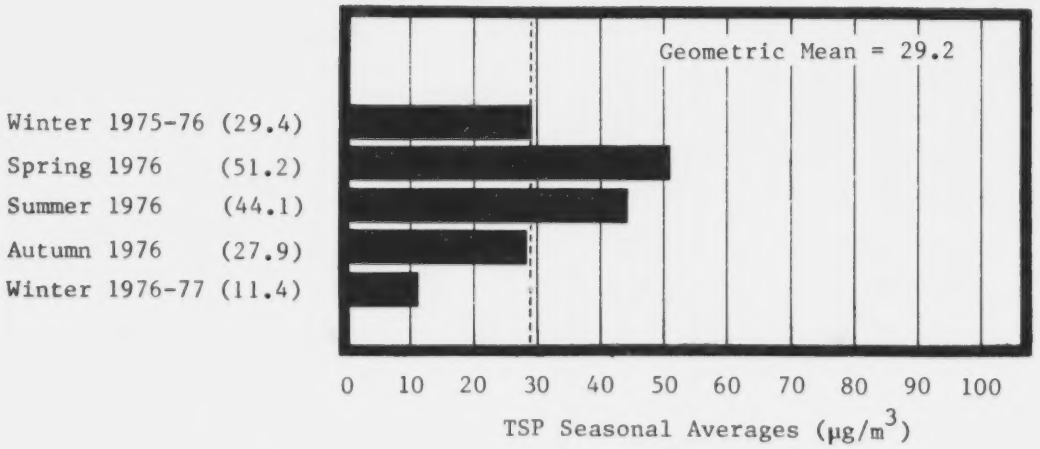


Figure 10. Kaibito, AZ, seasonal TSP averages.

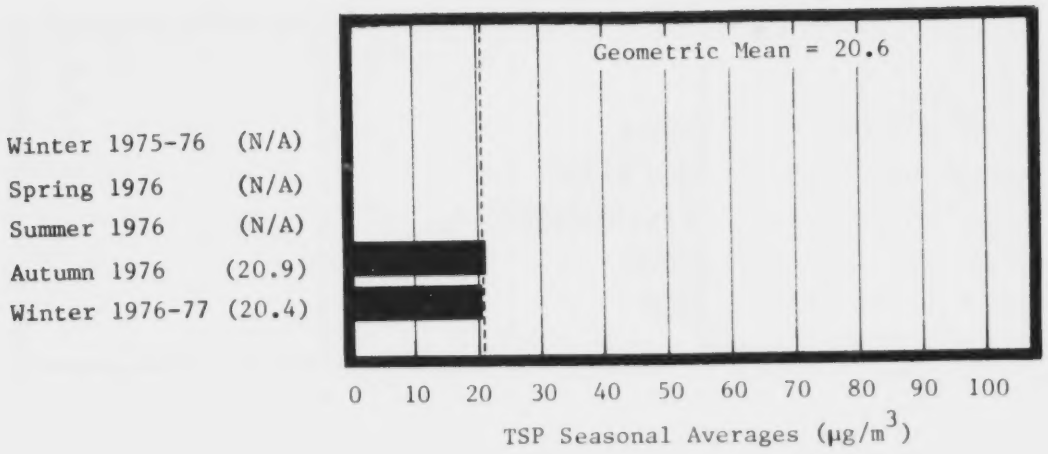

Winter 1975-76 (N/A)
Spring 1976 (N/A)
Summer 1976 (N/A)
Autumn 1976 (20.9)
Winter 1976-77 (20.4)
Geometric Mean = 20.6
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (μg/m3)

Figure 11. Lee's Ferry, AZ, seasonal TSP averages.

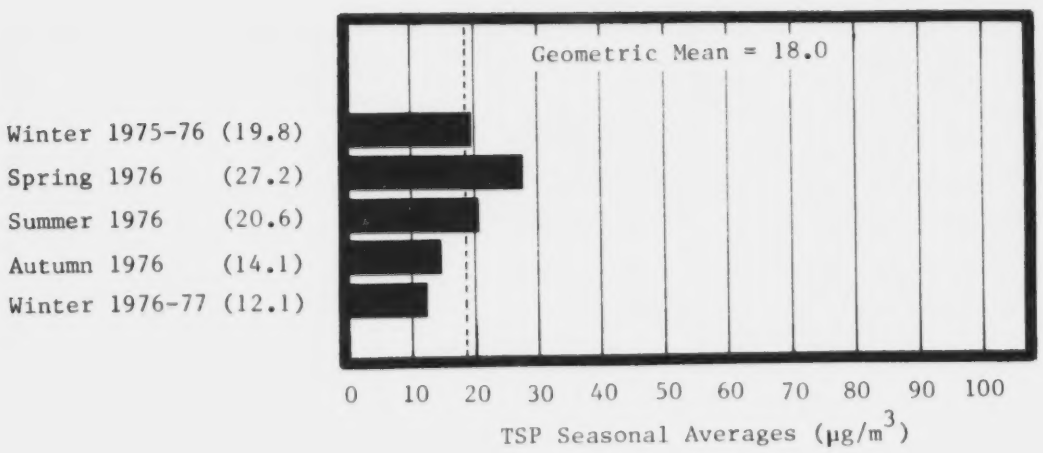


Figure 12. Piute, AZ, seasonal TSP averages.

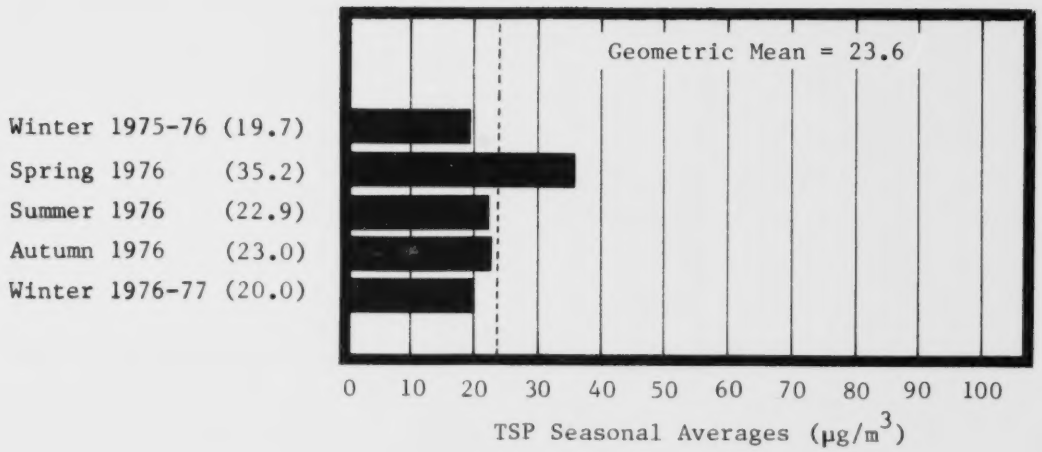


Figure 13. Redrock, AZ, seasonal TSP averages.

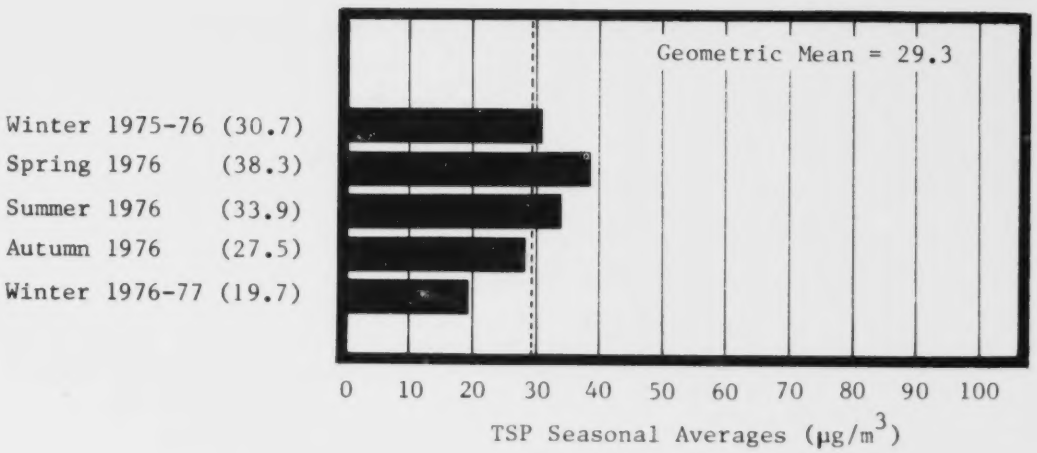


Figure 14. Teec Nos Pos, AZ, seasonal TSP averages.

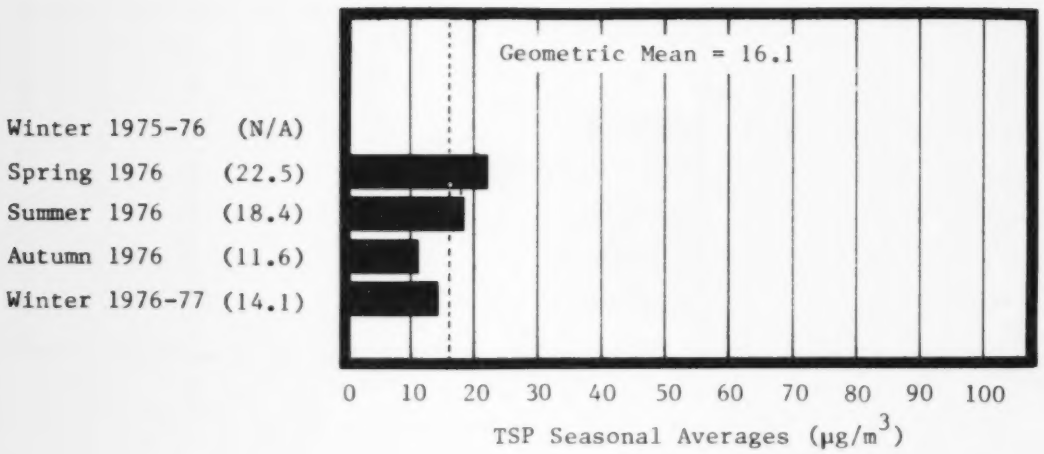

Geometric Mean = 16.1
Winter 1975-76 (N/A)
Spring 1976 (22.5)
Summer 1976 (18.4)
Autumn 1976 (11.6)
Winter 1976-77 (14.1)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 15. Tsa Schizzi, AZ, seasonal TSP averages.

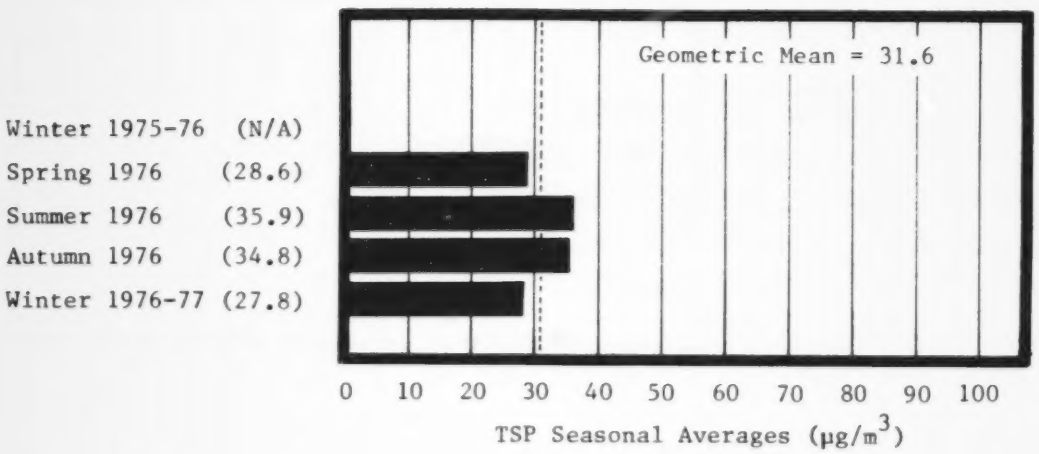

Geometric Mean = 31.6
Winter 1975-76 (N/A)
Spring 1976 (28.6)
Summer 1976 (35.9)
Autumn 1976 (34.8)
Winter 1976-77 (27.8)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 16. Tuba City, AZ, seasonal TSP averages.

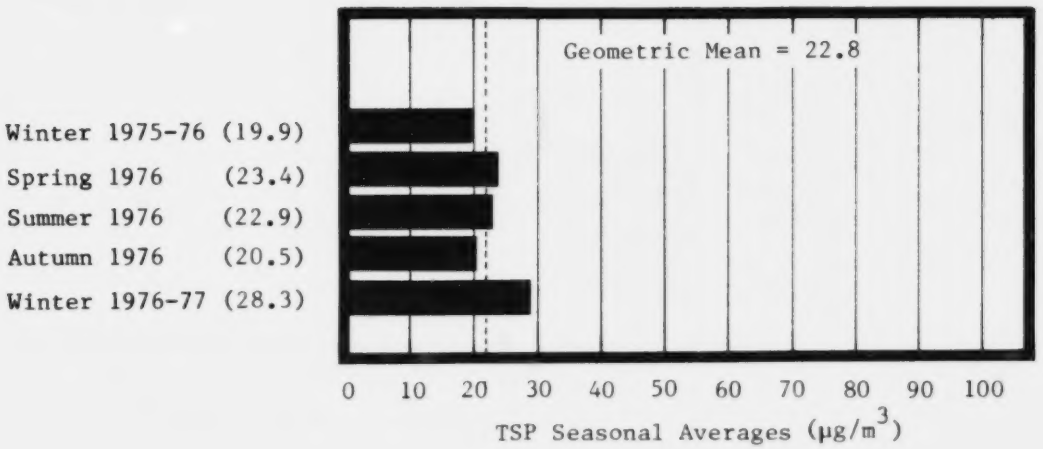


Figure 17. Ignacio, CO, seasonal TSP averages.

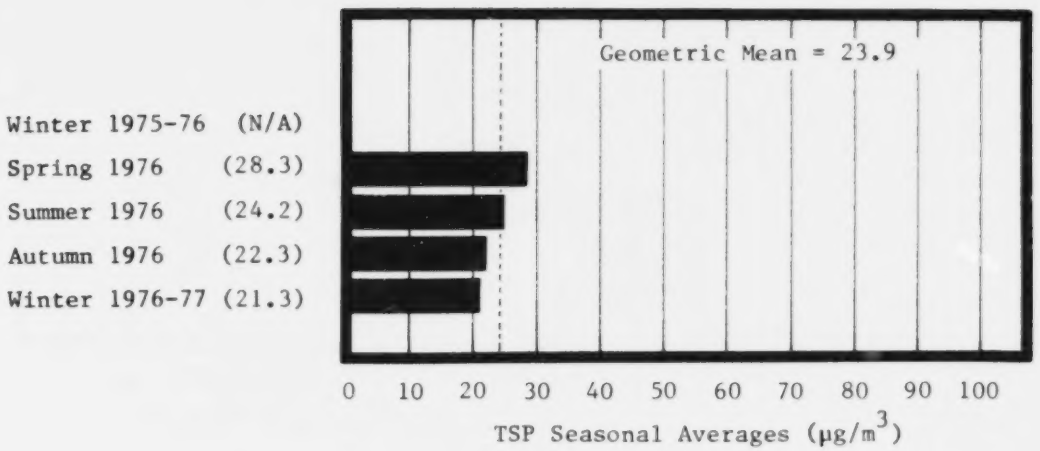

Geometric Mean = 23.9
Winter 1975-76 (N/A)
Spring 1976 (28.3)
Summer 1976 (24.2)
Autumn 1976 (22.3)
Winter 1976-77 (21.3)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 18. Redmesa, CO, seasonal TSP averages.

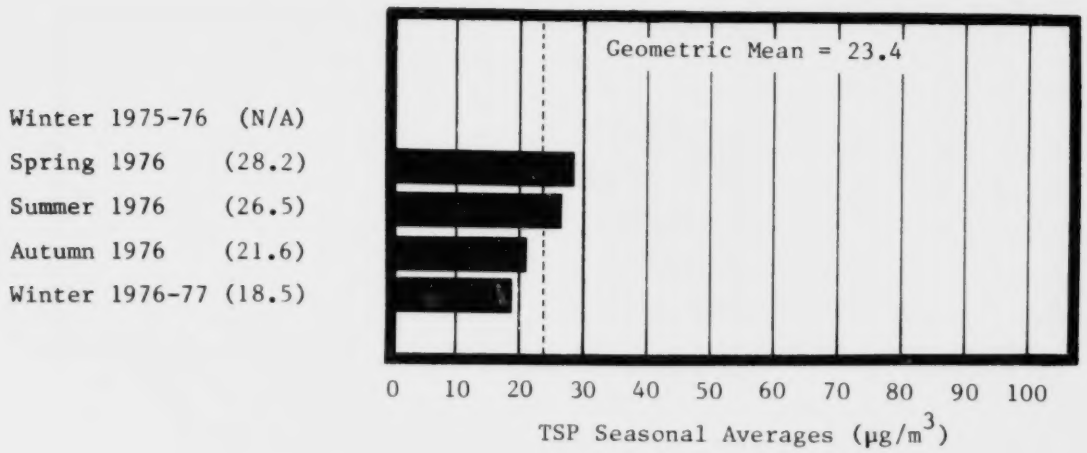

Winter 1975-76 (N/A)
Spring 1976 (28.2)
Summer 1976 (26.5)
Autumn 1976 (21.6)
Winter 1976-77 (18.5)
Geometric Mean = 23.4
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 19. Towaoc, CO, seasonal TSP averages.

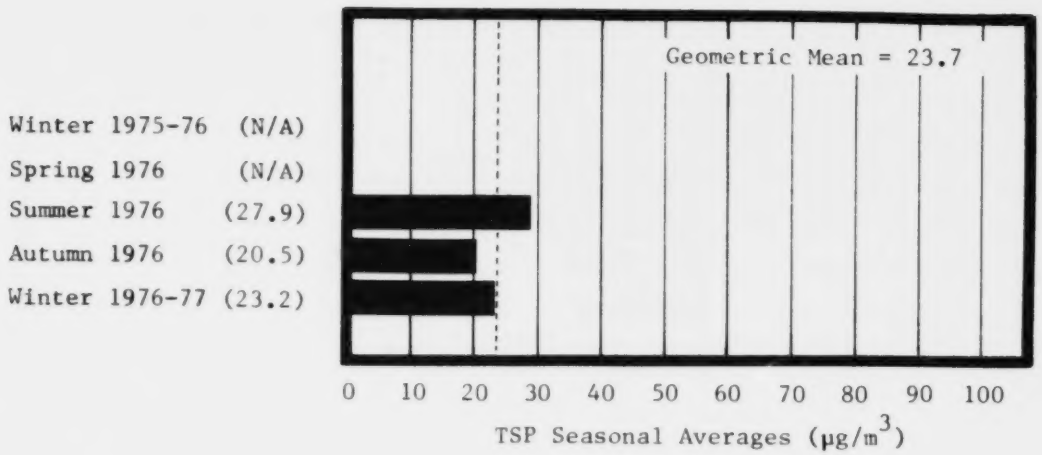

Winter 1975-76 (N/A)
Spring 1976 (N/A)
Summer 1976 (27.9)
Autumn 1976 (20.5)
Winter 1976-77 (23.2)
Geometric Mean = 23.7
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 20. Burnham, NM, seasonal TSP averages.

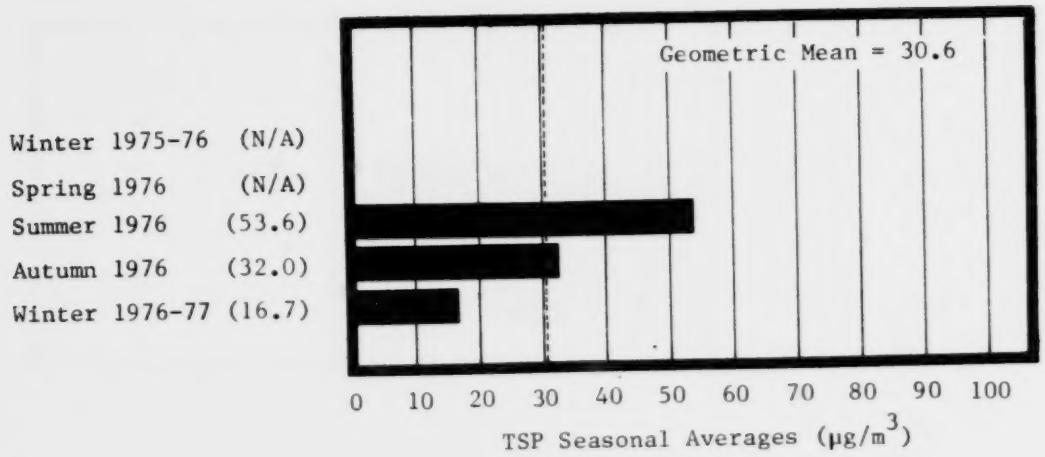

Geometric Mean = 30.6
Winter 1975-76 (N/A)
Spring 1976 (N/A)
Summer 1976 (53.6)
Autumn 1976 (32.0)
Winter 1976-77 (16.7)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 21. Chaco Canyon, NM, seasonal TSP averages.

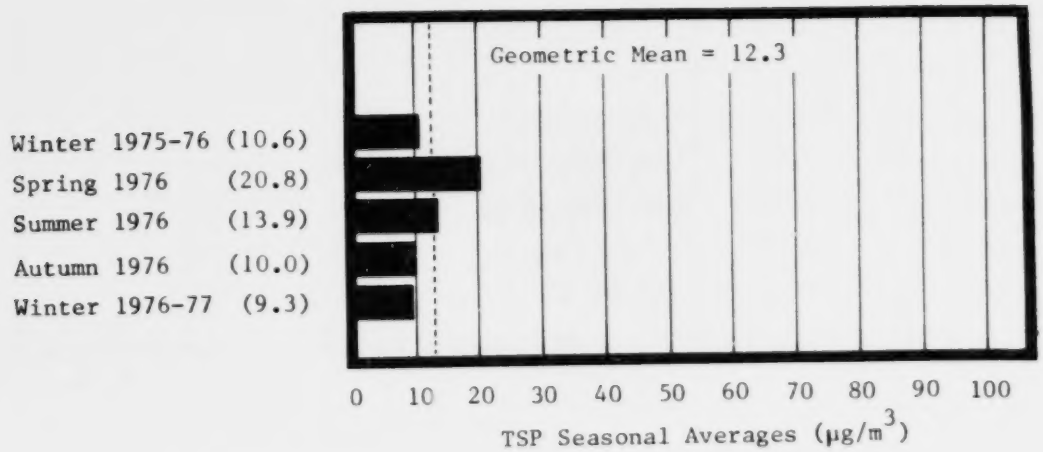

Geometric Mean = 12.3
Winter 1975-76 (10.6)
Spring 1976 (20.8)
Summer 1976 (13.9)
Autumn 1976 (10.0)
Winter 1976-77 (9.3)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 22. Dulce, NM, seasonal TSP averages.

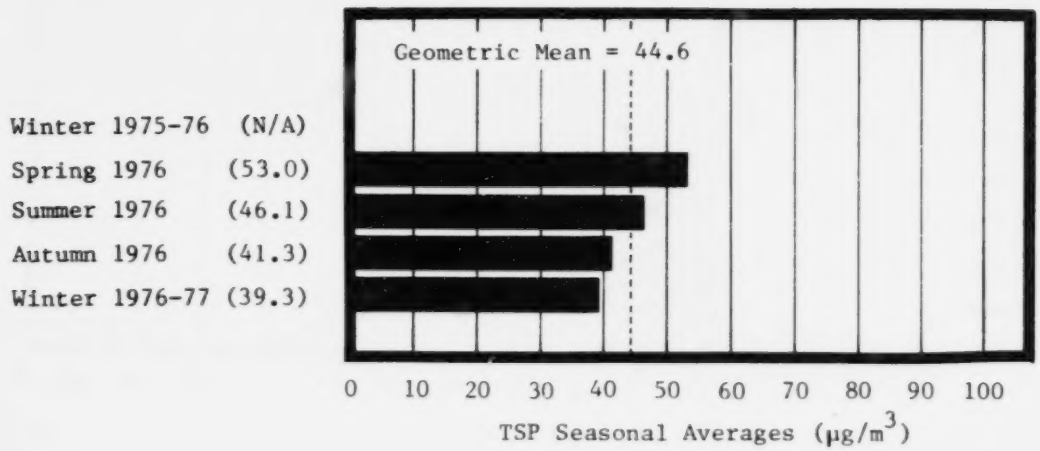

Geometric Mean = 44.6
Winter 1975-76 (N/A)
Spring 1976 (53.0)
Summer 1976 (46.1)
Autumn 1976 (41.3)
Winter 1976-77 (39.3)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 23. Huerfano, NM, seasonal TSP averages.

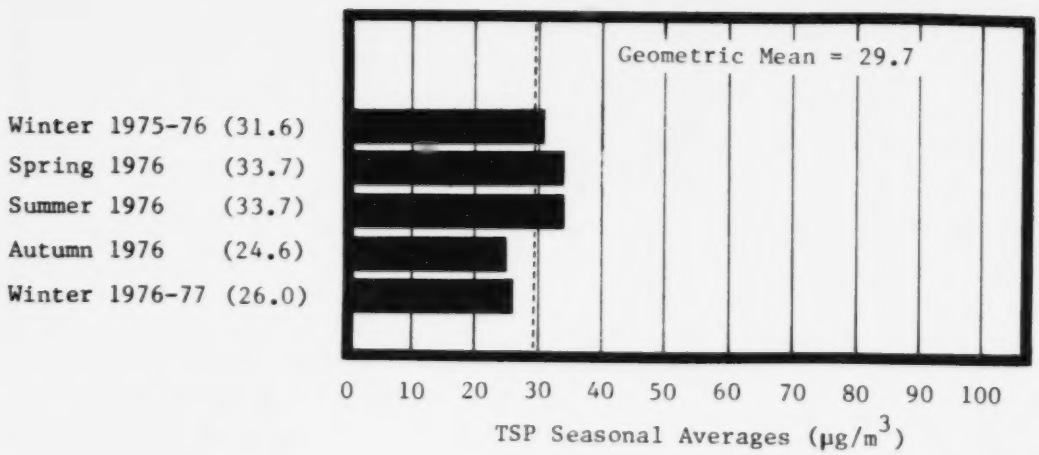


Figure 24. Aneth, UT, seasonal TSP averages.

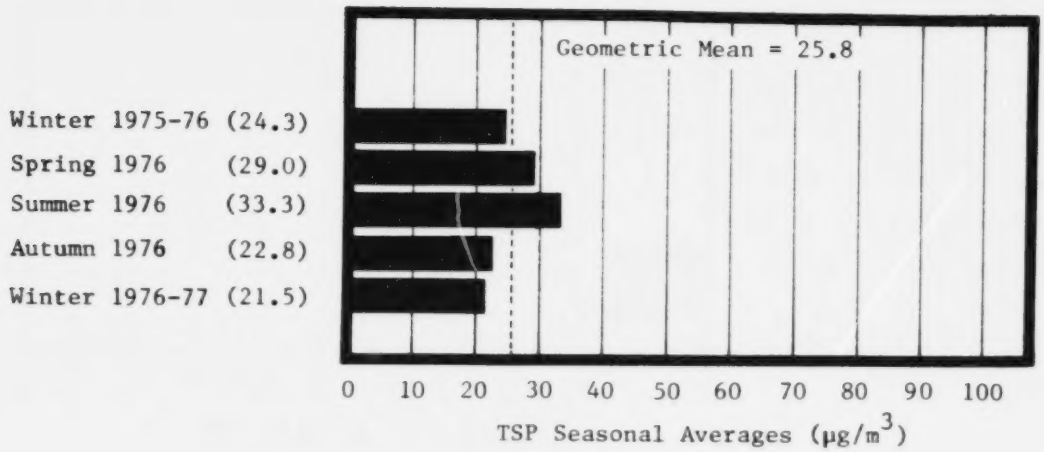


Figure 25. Bloomington, UT, seasonal TSP averages.

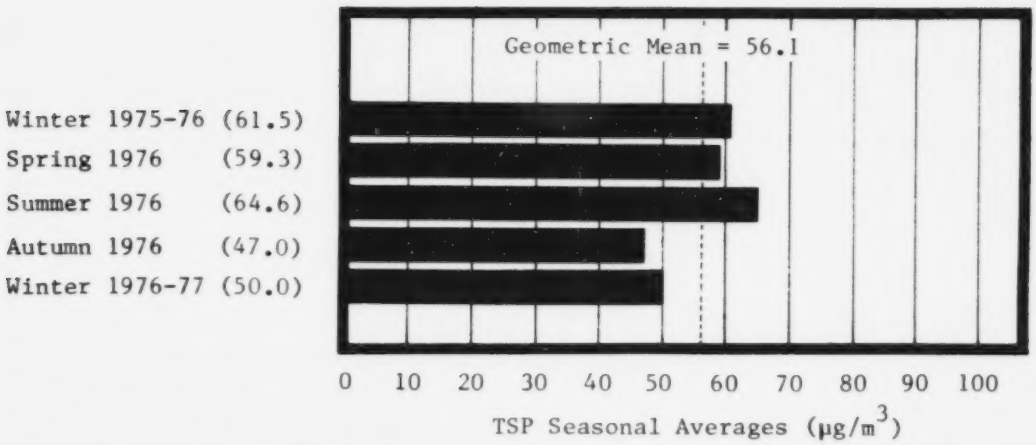


Figure 26. Escalante, UT, seasonal TSP averages.

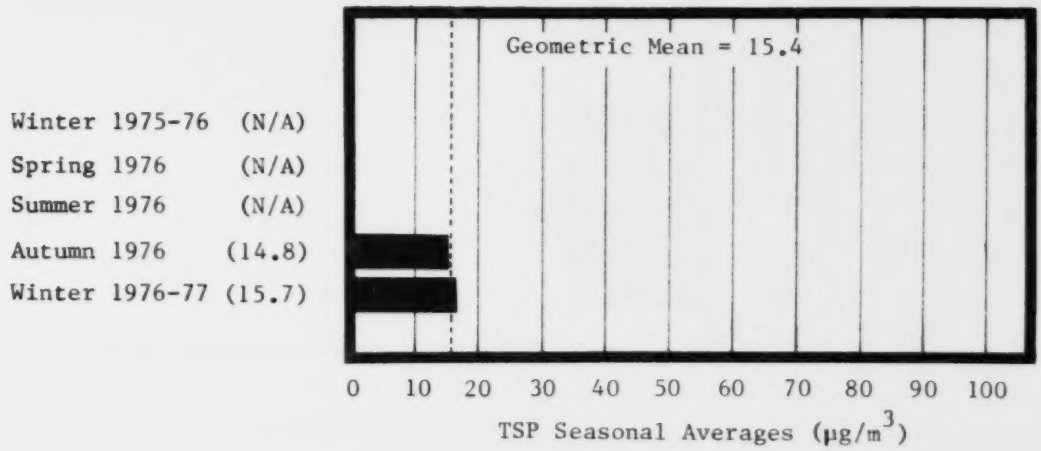

Geometric Mean = 15.4
Winter 1975-76 (N/A)
Spring 1976 (N/A)
Summer 1976 (N/A)
Autumn 1976 (14.8)
Winter 1976-77 (15.7)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 27. Glen Canyon, UT, seasonal TSP averages.

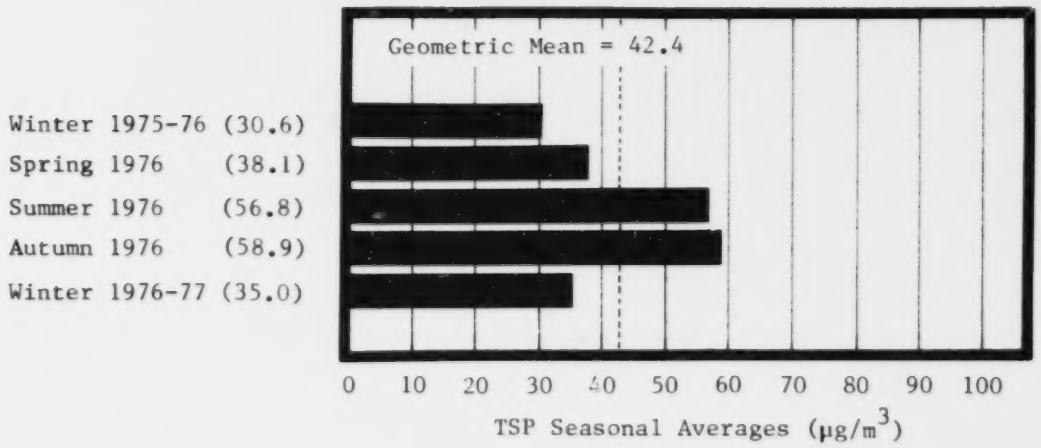


Figure 28. Henrieville, UT, seasonal TSP averages.

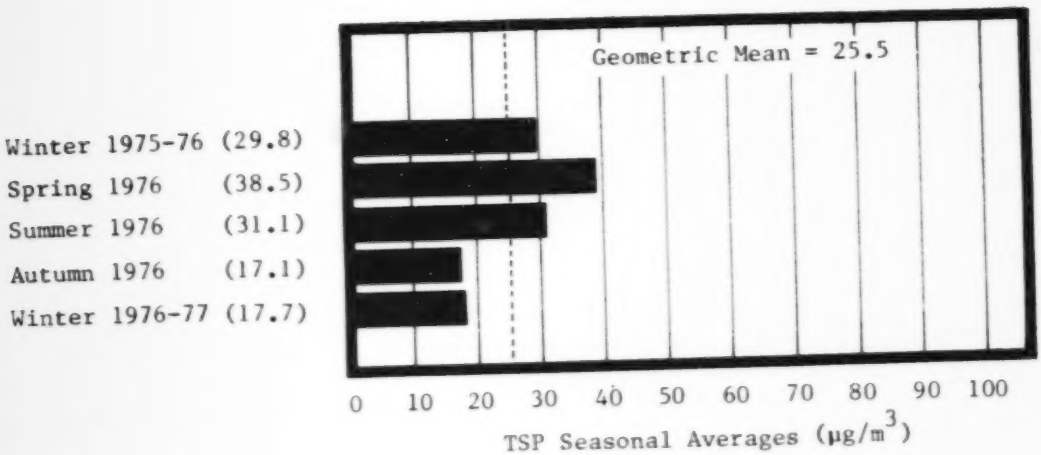


Figure 29. Oljato, UT, seasonal TSP averages.

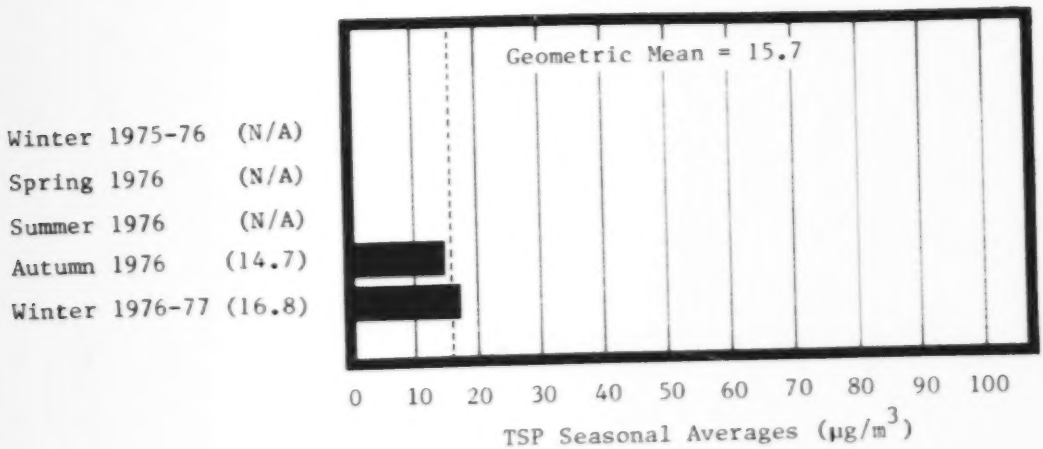

Geometric Mean = 15.7
Winter 1975-76 (N/A)
Spring 1976 (N/A)
Summer 1976 (N/A)
Autumn 1976 (14.7)
Winter 1976-77 (16.8)
0 10 20 30 40 50 60 70 80 90 100
TSP Seasonal Averages (µg/m3)

Figure 30. St. George, UT, seasonal TSP averages.

REFERENCES

Thompson, R.J., Morgan, G.B., and Purdue, L.J., Division of Air Quality and Emission Data, U.S. Department of Health, Education, and Welfare, National Air Pollution Control Administration, Cincinnati, OH. "Analysis of Selected Elements in Atmospheric Particulate Matter by Atomic Absorption," Atomic Absorption Newsletter, Vol. 9, No. 3, May-June 1970, pp. 53-57.

APPENDIX A

DATA FLOW

Figure A-1 illustrates the flow of data and samples within the course of accomplishing this program. This chart shows the interrelationships of the mainline data collection/analysis tasks with the external and internal quality assurance programs.

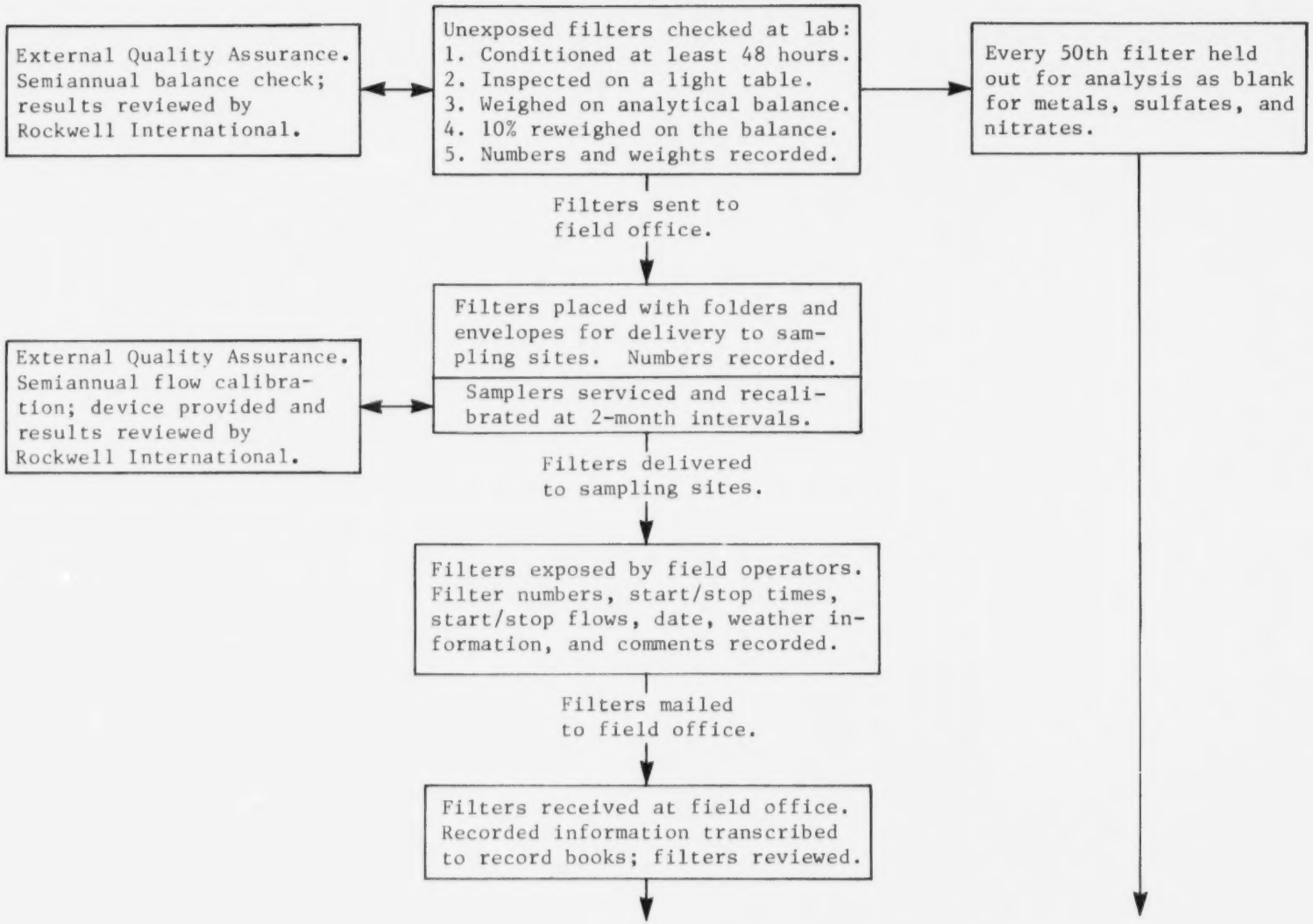

External Quality Assurance. Semiannual balance check; results reviewed by Rockwell International.
Unexposed filters checked at lab:
1. Conditioned at least 48 hours.
2. Inspected on a light table.
3. Weighed on analytical balance.
4. 10% reweighed on the balance.
5. Numbers and weights recorded.
Every 50th filter held out for analysis as blank for metals, sulfates, and nitrates.
Filters sent to field office.
Filters placed with folders and envelopes for delivery to sampling sites. Numbers recorded.
External Quality Assurance. Semiannual flow calibration; device provided and results reviewed by Rockwell International.
Samplers serviced and recalibrated at 2-month intervals.
Filters delivered to sampling sites.
Filters exposed by field operators. Filter numbers, start/stop times, start/stop flows, date, weather information, and comments recorded.
Filters mailed to field office.
Filters received at field office. Recorded information transcribed to record books; filters reviewed.

Figure A-1. Program data flow (continued).

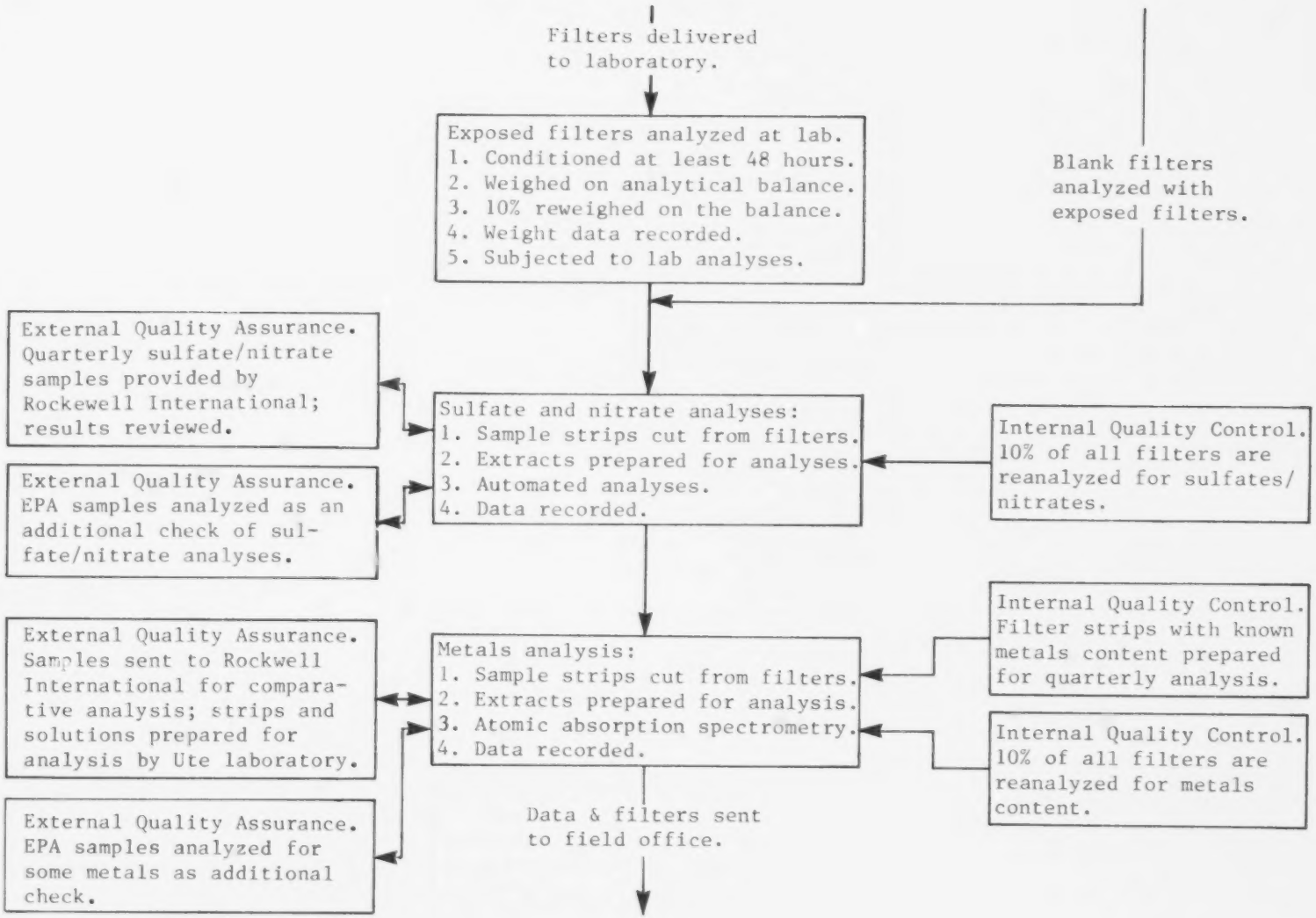

Filters delivered to laboratory.
Exposed filters analyzed at lab.
1. Conditioned at least 48 hours.
2. Weighed on analytical balance.
3. 10% reweighed on the balance.
4. Weight data recorded.
5. Subjected to lab analyses.
Blank filters analyzed with exposed filters.
External Quality Assurance. Quarterly sulfate/nitrate samples provided by Rockewell International; results reviewed.
External Quality Assurance. EPA samples analyzed as an additional check of sulfate/nitrate analyses.
Sulfate and nitrate analyses:
1. Sample strips cut from filters.
2. Extracts prepared for analyses.
3. Automated analyses.
4. Data recorded.
Internal Quality Control. 10% of all filters are reanalyzed for sulfates/nitrates.
External Quality Assurance. Samples sent to Rockwell International for comparative analysis; strips and solutions prepared for analysis by Ute laboratory.
External Quality Assurance. EPA samples analyzed for some metals as additional check.
Metals analysis:
1. Sample strips cut from filters.
2. Extracts prepared for analysis.
3. Atomic absorption spectrometry.
4. Data recorded.
Internal Quality Control. Filter strips with known metals content prepared for quarterly analysis.
Internal Quality Control. 10% of all filters are reanalyzed for metals content.
Data & filters sent to field office.

Figure A-1. Program data flow (continued).

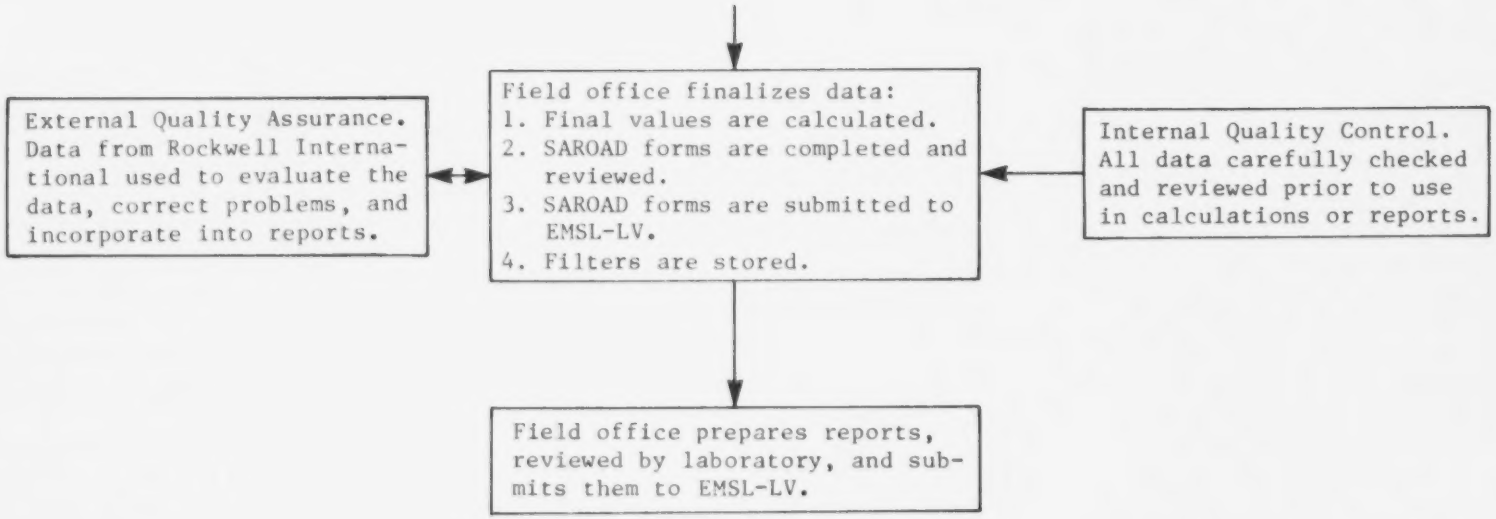

External Quality Assurance. Data from Rockwell International used to evaluate the data, correct problems, and incorporate into reports.
Field office finalizes data:
1. Final values are calculated.
2. SAROAD forms are completed and reviewed.
3. SAROAD forms are submitted to EMSL-LV.
4. Filters are stored.
Internal Quality Control. All data carefully checked and reviewed prior to use in calculations or reports.
Field office prepares reports, reviewed by laboratory, and submits them to EMSL-LV.

Figure A-1. Program data flow.

APPENDIX B

MONITORING STATIONS AND DATA

GENERAL DESCRIPTION

This appendix contains individual site descriptions and data summaries for the 29 monitoring stations that comprise the Ute Research Laboratories' amibent air monitoring network. The network, the stations, and the equipment at each station are described in Section 4.

For each station, a table is included that summarizes the seasonal averages for the data obtained. In terms of the TSP and the individual trace metals, the tables show the average concentrations obtained during the winter quarter of 1975-76 (December, January, and February), the spring quarter of 1976 (March, April, and May), the summer quarter of 1976 (June, July, and August), the autumn quarter of 1976 (September, October, and November), and the winter quarter of 1976-77 (December, January, and February). The maxumum daily value, the second highest daily value, the arithmetic mean value, the geometric mean value, and the number of samples for TSP monitoring during the 1976 calendar year also are presented for each site. These values are based on all available data for the year and may not represent statistically valid means.

As mentioned in Sections 8 and 9, the quality of the trace-metals data is questionable. Therefore, these data should be used with caution and are provided primarily as an indication of trace-metal values in this area.

The SAROAD minimum detectable limits were used in the average values for metal concentrations that were below the detection concentration. These limits are 0.001 $\mu g/m^3$ for cadmium, 0.002 $\mu g/m^3$ for chromium, 0.004 $\mu g/m^3$ for cobalt, 0.001 $\mu g/m^3$ for copper, 0.002 $\mu g/m^3$ for lead, 0.001 $\mu g/m^3$ for manganese, 0.004 $\mu g/m^3$ for molybdenum, and 0.010 $\mu g/m^3$ for iron.

ARIZONA MONITORING STATIONS

There are 11 monitoring stations operating in the northern portion of Arizona. The following paragraphs describe each of these stations in detail.

Bacobi, AZ (SAROAD Number 030520003K03)

The Bacobi monitoring station is located in the northwest corner of the Hopi Indian Reservation. The site is approximately 120 km (75 mi) south of

the Navajo Generating Station and 40 km (25 mi) south of the Black Mesa Coal Mine, both of which constitute potential or actual stationary emission sources. There are few paved roads in the general vicinity of the station, but the small village of Bacobi (approximate population of 200) is located nearby. The terrain is generally flat, consisting of sandy soil with only sparse vegetation. The major commercial activity in this area is livestock grazing.

The station is operated by a field operator employed by Ute Research Laboratories and was activated in February 27, 1976. It is equipped with a single high-volume air sampler and a flow recorder, with commercial electrical power available at the site. Table B-1 summarizes the data.

TABLE B-1. BACOBI SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	35.1	29.8	14.4	18.3
TSP* (Geometric)	N/A	27.5	23.7	10.5	11.9
Cadmium	N/A	0.001	0.001	0.001	0.001
Chromium	N/A	0.004	0.002	0.002	0.002
Cobalt	N/A	0.006	0.004	0.004	0.004
Copper	N/A	0.044	0.062	0.067	0.096
Lead	N/A	0.018	0.018	0.010	0.007
Manganese	N/A	0.009	0.005	0.006	0.008
Nickel	N/A	0.005	0.004	0.004	0.004
Molybdenum	N/A	0.002	0.002	0.002	0.002
Iron	N/A	0.414	0.472	0.202	0.204
No. of Samples	N/A	25	39	38	35

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	207.6
Second Highest Daily Value	154.9
Arithmetic Mean Value	24.6
Geometric Mean Value	16.9
Number of Samples	137

Bodaway, AZ (SAROAD Number 030200012K03)

The Bodaway monitoring station is located in the western portion of the Navajo Indian Reservation near the Colorado River and the Grand Canyon National Park. The site is about 56 km (35 mi) southwest of the Navajo Generating Station and 16 km (10 mi) east of the Cedar Ridge Trading Post on U.S. Highway 89. Although slightly hilly, the terrain is predominantly flat. The sandy soil has many rock outcroppings and supports sparse vegetation, with livestock grazing being the only commercial activity. U.S. Highway 89 is the

only paved road in the vicinity, providing the only main access to the few, widely scattered homes occupying this remote area.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on June 21, 1976. There is no commercial electrical power, so the station is equipped with a propane electrical generator as well as a single high-volume air sampler and a flow recorder. Table B-2 summarizes the data.

TABLE B-2. BODAWAY SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	N/A	55.2	19.7	35.8
TSP* (Geometric)	N/A	N/A	48.5	17.0	13.0
Cadmium	N/A	N/A	0.001	0.001	0.001
Chromium	N/A	N/A	0.003	0.003	0.002
Cobalt	N/A	N/A	0.004	0.004	0.004
Copper	N/A	N/A	0.043	0.044	0.070
Lead	N/A	N/A	0.010	0.010	0.006
Manganese	N/A	N/A	0.010	0.011	0.004
Nickel	N/A	N/A	0.005	0.004	0.004
Molybdenum	N/A	N/A	0.002	0.002	0.002
Iron	N/A	N/A	0.645	0.345	0.182
No. of Samples	N/A	N/A	24	18	34

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	370.0
Second Highest Daily Value	353.3
Arithmetic Mean Value	38.1
Geometric Mean Value	22.0
Number of Samples	76

Coppermine, AZ (SAROAD Number 030200011K03)

The Coppermine monitoring station is located in the western portion of the Navajo Indian Reservation about 40 km (25 mi) south of the Navajo Generating Station and 80 km (50 mi) northwest of the Black Mesa Coal Mine. The predominantly flat terrain has sandy soil, supporting only sparse vegetation for livestock grazing, the only commercial activity in the area. There are no paved roads within a radius of 16 km (10 mi), but there are a few, widely scattered homes and a trading post located about 1.6 km (1 mi) north of the station. An abandoned open-pit copper mine is located next to the trading post.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on February 2, 1976. It is equipped with a single high-volume air sampler and a flow recorder; commercial electrical power is available. Table B-3 summarizes the data.

TABLE B-3. COPPERMINE SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	20.2	27.2	36.9	14.1	11.7
TSP* (Geometric)	15.2	24.5	34.1	13.4	9.9
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.004	0.003	0.005	0.002	0.002
Cobalt	0.009	0.004	0.004	0.004	0.004
Copper	0.023	0.025	0.029	0.029	0.032
Lead	0.029	0.006	0.010	0.014	0.008
Manganese	0.003	0.005	0.010	0.006	0.004
Nickel	0.008	0.004	0.005	0.004	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.190	0.395	0.552	0.205	0.097
No. of Samples	10	13	25	16	29

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	662.8
Second Highest Daily Value	89.8
Arithmetic Mean Value	23.0
Geometric Mean Value	17.6
Number of Samples	93

Kaibito, AZ (SAROAD Number 030200010K03)

The Kaibito monitoring station is located on the Navajo Indian Reservation about 56 km (35 mi) southeast of the Navajo Generting Station and 64 km (40 mi) northwest of the Black Mesa Coal Mine. The slightly hilly terrain of the Kaibito Plateau has sandy soil, supporting sparse vegetation used for livestock grazing. Except for a paved highway about 1.6 km (1 mi) from the station, all roads in the area are dirt, providing access to a trading post and small tribal buildings about 0.8 km (0.5 mi) east of the station and to several homes and a school about 0.8 km (0.5 mi) west of the station.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on January 22, 1976. It is equipped with a single high-volume air sampler and a flow recorder, with commercial electrical power available at the site. Table B-4 summarizes the data.

TABLE B-4. KAIBITO SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	47.7	71.7	49.0	33.9	17.4
TSP* (Geometric)	29.4	51.2	44.1	27.4	11.4
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.004	0.003	0.003	0.002	0.002
Cobalt	0.007	0.007	0.005	0.004	0.004
Copper	0.032	0.025	0.027	0.025	0.019
Lead	0.024	0.014	0.023	0.011	0.007
Manganese	0.001	0.008	0.013	0.012	0.009
Nickel	0.007	0.005	0.004	0.004	0.004
Molybdenum	0.002	0.003	0.003	0.002	0.002
Iron	0.190	0.486	0.643	0.376	0.166
No. of Samples	21	31	32	34	34

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	253.4
Second Highest Daily Value	215.8
Arithmetic Mean Value	43.0
Geometric Mean Value	29.2
Number of Samples	152

Lechee, AZ (SAROAD Number 030200005K03)

The Lechee monitoring station is located on the Navajo Indian Reservation approximately 4.8 km (3 mi) south of the Navajo Generating Station. The monitoring station is situated on the top of a small mesa that has bare rock in and around the immediate vicinity of the station, but very sandy soil around the mesa. To the northwest, the city of Page, AZ, is about 6.4 km (4 mi) away, and the Glen Canyon Dam is 8 km (5 mi) away. A small housing development with paved roads is located about 0.8 km (0.5 mi) west of the station.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on May 22, 1977. It is equipped with a single high-volume air sampler and a low-volume air sampler that are operated on the same days. Commercial electrical power is available.

Since the site was activated after the end of the data collection period covered by this report, no data are included herein.

Lee's Ferry, AZ (SAROAD Number 030200007K03)

The Lee's Ferry monitoring station is located in the Glen Canyon National Recreation Area. It is situated in the bottom of the Glen Canyon, at the head of Marble Canyon, about 19 km (12 mi) west of Page, AZ. A small campground

and four homes for National Park Service personnel are 0.8 km (0.5 mi) west of the station, and a boat launching ramp and small store are 0.8 km (0.5 mi) east of the station. A small water treatment plant and a boat storage area are immediately adjacent to the monitoring station, and the road leading to the site is paved. The National Park Service prohibits any vehicles from leaving the paved road at any time.

This station is operated by National Park Service Personnel and was activated on October 5, 1976. It is equipped with a single high-volume air sampler and a flow recorder, and it also is equipped with a 24-hr timer for the convenience of the National Park Service personnel. Commercial electrical power is available. Table B-5 summarizes the data.

TABLE B-5. LEE'S FERRY SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	N/A	N/A	41.9	31.2
TSP* (Geometric)	N/A	N/A	N/A	20.9	20.4
Cadmium	N/A	N/A	N/A	0.001	0.001
Chromium	N/A	N/A	N/A	0.002	0.002
Cobalt	N/A	N/A	N/A	0.004	0.004
Copper	N/A	N/A	N/A	0.008	0.011
Lead	N/A	N/A	N/A	0.011	0.011
Manganese	N/A	N/A	N/A	0.010	0.009
Nickel	N/A	N/A	N/A	0.004	0.004
Molybdenum	N/A	N/A	N/A	0.002	0.002
Iron	N/A	N/A	N/A	0.290	0.358
No. of Samples	N/A	N/A	N/A	24	37

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	481.0
Second Highest Daily Value	255.7
Arithmetic Mean Value	35.4
Geometric Mean Value	20.6
Number of Samples	61

Piute, AZ (SAROAD Number 030500009K03)

The Piute monitoring station is located on the Kaibab-Piute Indian Reservation. It is approximately 105 km (65 mi) west of the Navajo Generating Station and 64 km (40 mi) east of the proposed Warner Valley Power Plant. About 3.2 km (2 mi) north of the monitoring station is a small town (approximate population of 100) having some farming enterprises. Livestock grazing is common to the entire area. The Pipe Springs National Monument and a tribal office building are about 3.2 km (2 mi) south of the station, and several homes are in the immediate vicinity of the station. The road to the

station is paved, but most others are packed dirt. The predominantly flat terrain has sandy soil and sparse to moderate vegetation. A high plateau is northwest of the valley in which the station is located, and a sawmill and small oil refinery are located about 32 km (20 mi) east of the station.

This station is operated by a field operator employed by Ute Research Laboratories and was activated on January 27, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-6 summarizes the data.

TABLE B-6. PIUTE SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	28.8	35.9	23.1	16.6	14.0
TSP* (Geometric)	19.8	27.2	20.6	14.1	12.1
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.004	0.002	0.002	0.002	0.003
Cobalt	0.008	0.004	0.004	0.004	0.004
Copper	0.041	0.023	0.023	0.010	0.002
Lead	0.035	0.007	0.012	0.012	0.010
Manganese	0.002	0.003	0.005	0.007	0.005
Nickel	0.008	0.004	0.004	0.004	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.336	0.403	0.431	0.230	0.141
No. of Samples	14	33	30	38	36

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	192.8
Second Highest Daily Value	134.3
Arithmetic Mean Value	23.6
Geometric Mean Value	18.0
Number of Samples	151

Redrock, AZ (SAROAD Number 03004000K03)

The Redrock monitoring station is located on the Navajo Indian Reservation approximately 64 km (40 mi) west of the Four Corners Power Plant, 80 km (50 mi) southwest of the San Juan Power Plant, and 48 km (30 mi) north of the Canyon De Chelly National Monument. This is a remote, relatively isolated area, with the nearest paved road 16 km (10 mi) away. The area has many widely scattered homes and a small school. The predominantly flat terrain has mountains located to the west. It is a sandy area, supporting only sparse vegetation other than that growing on the mountains.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on January 12, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-7 summarizes the data.

TABLE B-7. REDROCK SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	22.8	44.3	29.0	26.5	27.3
TSP* (Geometric)	19.7	35.2	22.9	23.0	20.0
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.006	0.003	0.002	0.002	0.002
Cobalt	0.012	0.005	0.004	0.004	0.004
Copper	0.021	0.019	0.019	0.004	0.005
Lead	0.031	0.022	0.017	0.008	0.006
Manganese	0.002	0.007	0.013	0.009	0.008
Nickel	0.009	0.004	0.005	0.004	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.139	0.499	0.646	0.282	0.191
No. of Samples	18	28	33	38	38

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	127.6
Second Highest Daily Value	124.8
Arithmetic Mean Value	31.0
Geometric Mean Value	23.6
Number of Samples	155

Teec Nos Pos, AZ (SAROAD Number 030040001K03)

The Teec Nos Pos monitoring station is located on the Navajo Indian Reservation about 64 km (40 mi) northwest of the Four Corners Power Plant and 56 km (35 mi) northwest of the San Juan Power Plant. It is 89 km (55 mi) north of the Canyon De Chelly National Monument. Except for the main highway, the roads in the area are not paved. A large school and a housing development are located 1.6 km (1 mi) east of the station, with some farming and a few oil wells in the general area. The terrain is typically flat, with sandy soil and sparse to moderate vegetation other than in the areas being farmed.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on January 20, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-8 summarizes the data.

TABLE B-8. TEEC NOS POS SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	38.3	57.9	44.7	35.6	27.0
TSP* (Geometric)	30.7	38.3	33.9	27.5	19.7
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.007	0.003	0.002	0.002	0.002
Cobalt	0.010	0.005	0.004	0.004	0.004
Copper	0.038	0.034	0.038	0.018	0.047
Lead	0.047	0.014	0.019	0.033	0.022
Manganese	0.004	0.001	0.008	0.010	0.006
Nickel	0.005	0.004	0.004	0.004	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.192	0.404	0.600	0.340	0.202
No. of Samples	18	34	26	36	27

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	473.0
Second Highest Daily Value	170.7
Arithmetic Mean Value	42.4
Geometric Mean Value	29.3
Number of Samples	141

Tsa Schizzi, AZ (SAROAD Number 030200013K03)

The Tsa Schizzi monitoring station is located in a remote section of the Navajo Indian Reservation about 32 km (20 mi) east of the Navajo Generating Station. The terrain is generally flat with some large rock outcroppings, sandy soil, and sparse vegetation. Livestock grazing is the only commercial pursuit in this area. There are no paved roads, and homes are very widely scattered.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on April 2, 1976. There is no commercial electrical power in the area, so the station is equipped with a propane electrical generator. It also is equipped with a single high-volume air sampler and a flow recorder. Table B-9 summarizes the data.

TABLE B-9. TSA SCHIZZI SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	24.4	20.8	12.4	18.1
TSP* (Geometric)	N/A	22.5	18.4	11.6	14.1
Cadmium	N/A	0.001	0.001	0.001	0.001
Chromium	N/A	0.002	0.002	0.002	0.002
Cobalt	N/A	0.004	0.004	0.004	0.004
Copper	N/A	0.020	0.014	0.015	0.016
Lead	N/A	0.005	0.008	0.009	0.008
Manganese	N/A	0.001	0.004	0.004	0.006
Nickel	N/A	0.004	0.005	0.004	0.004
Molybdenum	N/A	0.002	0.002	0.002	0.002
Iron	N/A	0.315	0.352	0.172	0.176
No. of Samples	N/A	10	15	20	22

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	101.9
Second Highest Daily Value	57.4
Arithmetic Mean Value	17.9
Geometric Mean Value	16.1
Number of Samples	67

Tuba City, AZ (SAROAD Number 030200014K03)

The Tuba City monitoring station is located on a Navajo Indian Reservation about 97 km (60 mi) south of the Navajo Generating Station and 56 km (35 mi) east of the Grand Canyon National Park boundary. The site is located 1.6 km (1 mi) north of Tuba City, accessible by a dirt road from the town. Most of the roads within the small town of Tuba City are paved, but those outside of the city limits are dirt. The terrain is mostly flat, with some rolling hills. The ground is very sandy, supporting only sparse vegetation.

The station is operated by a field operator employed by Ute Research Laboratories and originally was activated on February 6, 1976. Originally, the site was 8 km (5 mi) to the east of its present location, but it was moved on October 6, 1976. The station is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-10 summarizes the data.

TABLE B-10. TUBA CITY SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	33.1	42.0	38.2	40.8
TSP* (Geometric)	N/A	28.6	35.9	34.8	27.8
Cadmium	N/A	0.001	0.001	0.001	0.001
Chromium	N/A	0.005	0.006	0.003	0.003
Cobalt	N/A	0.011	0.005	0.004	0.004
Copper	N/A	0.053	0.049	0.086	0.039
Lead	N/A	0.033	0.040	0.015	0.014
Manganese	N/A	0.009	0.017	0.016	0.010
Nickel	N/A	0.006	0.005	0.006	0.004
Molybdenum	N/A	0.002	0.002	0.002	0.002
Iron	N/A	0.519	0.855	0.488	0.367
No. of Samples	N/A	15	18	27	39

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	305.4
Second Highest Daily Value	123.6
Arithmetic Mean Value	39.1
Geometric Mean Value	31.6
Number of Samples	99

COLORADO MONITORING STATIONS

There are three monitoring stations operating in southwestern Colorado. The following paragraphs describe each of these in detail.

Ignacio, CO (SAROAD Number 061300003K03)

The Ignacio monitoring station is located about 4.8 km (3 mi) west of the small town of Ignacio, CO (approximate population of 800), on the Southern Ute Indian Reservation. The station is about 80 km (50 mi) northeast of the San Juan Power Plant and 97 km (60 mi) northeast of the Four Corners Power Plant. The semimountainous area is heavily farmed, and there are some oil wells in the immediate vicinity of the station. The station itself is located on an irrigated farm. Although there are many paved roads in the area, the road providing access to the monitoring station is dirt. Most of the area has moderate or dense vegetation, with good ground cover throughout the area.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on January 19, 1976. The station is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power was readily available. Table B-11 summarizes the data.

TABLE B-11. IGNACIO SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	24.6	35.4	27.8	22.8	35.1
TSP* (Geometric)	19.9	23.4	22.9	20.5	28.3
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.005	0.005	0.002	0.002	0.002
Cobalt	0.012	0.005	0.004	0.004	0.004
Copper	0.032	0.020	0.039	0.026	0.019
Lead	0.044	0.018	0.016	0.022	0.018
Manganese	0.005	0.008	0.003	0.008	0.007
Nickel	0.007	0.005	0.004	0.005	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.210	0.409	0.401	0.255	0.164
No. of Samples	18	25	21	32	35

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	188.3
Second Highest Daily Value	171.0
Arithmetic Mean Value	30.5
Geometric Mean Value	22.8
Number of Samples	131

Redmesa, CO (SAROAD Number 061300002K03)

The Redmesa monitoring station is located on the Southern Ute Indian Reservation approximately 56 km (35 mi) north of the Four Corners Power Plant, 40 km (25 mi) north of the San Juan Power Plant, and 48 km (30 mi) southeast of Mesa Verde National Park. The semimountainous area is extensively dry-land farmed, with some irrigation being done in the immediate vicinity of the station. Farm homes are scattered, and the roads are mostly dirt.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on April 19, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-12 summarizes the data.

TABLE B-12. REDMESA SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	32.4	31.1	24.8	29.7
TSP* (Geometric)	N/A	28.3	24.2	22.3	21.3
Cadmium	N/A	0.001	0.001	0.001	0.001
Chromium	N/A	0.003	0.003	0.002	0.002
Cobalt	N/A	0.007	0.005	0.004	0.004
Copper	N/A	0.024	0.014	0.012	0.008
Lead	N/A	0.016	0.016	0.014	0.011
Manganese	N/A	0.007	0.010	0.009	0.010
Nickel	N/A	0.005	0.005	0.004	0.004
Molybdenum	N/A	0.002	0.002	0.002	0.002
Iron	N/A	0.332	0.574	0.336	0.378
No. of Samples	N/A	17	33	37	34

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	80.2
Second Highest Daily Value	69.7
Arithmetic Mean Value	29.0
Geometric Mean Value	23.9
Number of Samples	121

Towaoc, CO (SAROAD Number 061600004K03)

The Towaoc monitoring station is located on the Ute Mountain Indian Reservation about 56 km (35 mi) northwest of the Four Corners Power Plant, 40 km (25 mi) north of the San Juan Power Plant, 16 km (10 mi) west of Mesa Verde National Park, and 24 km (15 mi) east of Hovenweep National Monument. The station is about 1.6 km (1 mi) east of Towaoc, CO (approximate population of 800), and 0.4 km (0.25 mi) from a paved road. The station is situated in an area of high, rocky mesas, but has been placed in the lowlands between the mesas. The soil is sandy, supporting only sparse vegetation, and the nearest farming activity is 8 km (5 mi) north of the station. Livestock grazing is the principal agricultural endeavor.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on April 29, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-13 summarizes the data.

TABLE B-13. TOWAOC SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	31.9	30.9	25.8	22.5
TSP* (Geometric)	N/A	28.2	26.5	21.6	18.5
Cadmium	N/A	0.001	0.001	0.001	0.001
Chromium	N/A	0.003	0.002	0.002	0.002
Cobalt	N/A	0.006	0.004	0.004	0.004
Copper	N/A	0.028	0.038	0.023	0.017
Lead	N/A	0.031	0.022	0.018	0.019
Manganese	N/A	0.007	0.004	0.008	0.003
Nickel	N/A	0.004	0.004	0.005	0.004
Molybdenum	N/A	0.003	0.002	0.002	0.002
Iron	N/A	0.300	0.339	0.292	0.191
No. of Samples	N/A	13	28	37	35

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	109.7
Second Highest Daily Value	80.6
Arithmetic Mean Value	26.7
Geometric Mean Value	23.4
Number of Samples	113

NEW MEXICO MONITORING STATIONS

There are five monitoring stations operating in northwestern New Mexico. The following paragraphs describe each station in detail.

Burnham, NM (SAROAD Number 321000012K03)

The Burnham monitoring station is located in a remote and isolated area about 40 km (25 mi) south of the Four Corners Power Plant and 56 km (35 mi) south of the San Juan Power Plant. It is approximately 48 km (30 mi) north of Chaco Canyon National Monument and is situated 4.8 km (3 mi) east of a small trading post and school as well as the only paved road in the area. Homes are very scattered, and the arid area contains many deep arroyos. The soil is sandy, supporting only sparse vegetation on which some livestock grazing takes place. However, the Burnham monitoring station is on the site of a proposed coal mine and coal gasification plant.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on May 17, 1976. There is no commercial electrical power, so the station is equipped with a propane electrical generator. It also is equipped with a single high-volume air sampler and a flow recorder. Table B-14 summarizes the data.

TABLE B-14. BURNHAM SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	N/A	43.3	26.8	44.4
TSP* (Geometric)	N/A	N/A	27.9	20.5	23.2
Cadmium	N/A	N/A	0.001	0.001	0.002
Chromium	N/A	N/A	0.002	0.004	0.002
Cobalt	N/A	N/A	0.004	0.004	0.004
Copper	N/A	N/A	0.020	0.035	0.031
Lead	N/A	N/A	0.017	0.009	0.009
Manganese	N/A	N/A	0.009	0.008	0.017
Nickel	N/A	N/A	0.005	0.005	0.004
Molybdenum	N/A	N/A	0.002	0.002	0.002
Iron	N/A	N/A	0.621	0.271	0.477
No. of Samples	N/A	N/A	23	30	30

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	569.3
Second Highest Daily Value	185.1
Arithmetic Mean Value	37.7
Geometric Mean Value	23.7
Number of Samples	83

Chaco Canyon, NM (SAROAD Number 321000011K03)

The Chaco Canyon monitoring station is located in the Chaco Canyon National Monument about 89 km (55 mi) southeast of the Four Corners Power Plant. This is a very isolated area, having no paved roads within a 40-km (25-mi) radius of the station. The area is sandy, with many bare-rock outcroppings and only sparse to moderate vegetation. The site is located in a canyon with steep, bare-rock sides. A small visitor center and three or four homes for National Park Service personnel are in the immediate vicinity of the station.

This station is operated by National Park Service personnel and was activated on June 30, 1976. It is equipped with a single high-volume air sampler and a flow recorder, and it also is equipped with a 24-hr timer for the convenience of the National Park Service personnel. Commercial electrical power is available. Table B-15 summarizes the data.

TABLE B-15. CHACO CANYON SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	N/A	59.6	38.2	19.9
TSP* (Geometric)	N/A	N/A	53.6	32.0	16.7
Cadmium	N/A	N/A	0.001	0.001	0.001
Chromium	N/A	N/A	0.002	0.002	0.003
Cobalt	N/A	N/A	0.004	0.004	0.004
Copper	N/A	N/A	0.011	0.004	0.003
Lead	N/A	N/A	0.017	0.010	0.009
Manganese	N/A	N/A	0.027	0.016	0.009
Nickel	N/A	N/A	0.004	0.004	0.004
Molybdenum	N/A	N/A	0.002	0.002	0.002
Iron	N/A	N/A	0.833	0.398	0.288
No. of Samples	N/A	N/A	20	24	31

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	113.2
Second Highest Daily Value	111.0
Arithmetic Mean Value	36.3
Geometric Mean Value	30.6
Number of Samples	75

Dulce, NM (SAROAD Number 320920003K03)

The Dulce monitoring station is located on the Jicarilla Apache Indian Reservation about 130 km (80 mi) east of the Four Corners Power Plant. The station is situated in an isolated area about 8 km (5 mi) south of the small town of Dulce, NM (approximate population of 800). The area is mountainous and forested, with one home in the forested area near the station. There is little agricultural activity other than some livestock grazing in the vicinity. The only road near the station is dirt.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on January 22, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-16 summarizes the data.

TABLE B-16. DULCE SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	11.2	29.1	17.0	11.8	14.8
TSP* (Geometric)	10.6	20.8	13.9	10.0	9.3
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.003	0.004	0.003	0.002	0.002
Cobalt	0.008	0.007	0.005	0.004	0.004
Copper	0.026	0.023	0.028	0.012	0.025
Lead	0.023	0.014	0.017	0.007	0.009
Manganese	0.002	0.007	0.005	0.004	0.005
Nickel	0.008	0.006	0.005	0.004	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.090	0.345	0.299	0.135	0.164
No. of Samples	14	25	37	39	38

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	207.4
Second Highest Daily Value	170.8
Arithmetic Mean Value	16.6
Geometric Mean Value	12.3
Number of Samples	153

Huerfano, NM (SAROAD Number 321000007K03)

The Huerfano monitoring station is located on the Navajo Indian Reservation about 48 km (30 mi) southeast of the Four Corners Power Plant and 64 km (40 mi) southeast of the San Juan Power Plant. The station is situated near a trading post and a tribal building of the Navajo Indian Tribe, with scattered homes throughout the area. A paved road leads to within 0.8 km (0.5 mi) of the station. The predominantly flat terrain has sandy soil with sparse vegetation, supporting little agricultural activity other than limited livestock grazing. However, there are numerous oil and natural gas wells throughout the area.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on April 13, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-17 summarizes the data.

TABLE B-17. HUERFANO SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	65.0	55.6	48.2	51.5
TSP* (Geometric)	N/A	53.0	46.1	41.3	39.3
Cadmium	N/A	0.001	0.001	0.001	0.001
Chromium	N/A	0.004	0.003	0.002	0.002
Cobalt	N/A	0.009	0.005	0.004	0.004
Copper	N/A	0.034	0.045	0.091	0.068
Lead	N/A	0.017	0.016	0.013	0.014
Manganese	N/A	0.010	0.011	0.012	0.012
Nickel	N/A	0.006	0.004	0.004	0.005
Molybdenum	N/A	0.003	0.002	0.002	0.002
Iron	N/A	0.678	0.646	0.409	0.484
No. of Samples	N/A	17	32	36	33

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	173.5
Second Highest Daily Value	170.9
Arithmetic Mean Value	53.6
Geometric Mean Value	44.6
Number of Samples	118

Navajo Farm Project, NM (SAROAD Number 321000021K03)

The Navajo Farm Project is located at an office and storage area for the Navajo Farming Project about 29 km (18 mi) east of the Four Corners Power Plant and 40 km (25 mi) southeast of the San Juan Power Plant. Much of the land is being irrigated extensively and farmed as part of the large project, and, during the growing season, good ground cover is being provided for the sandy soil by the crops. The main road to the monitoring station is paved, as are many of the other roads throughout this area, carrying a considerable amount of traffic involved in the farming activities.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on February 6, 1977. It is equipped with a low-volume air sampler. Commercial electrical power is available.

Since the station was activated near the end of the data collection period covered by this report, no data are included herein.

UTAH MONITORING STATIONS

There are 10 monitoring stations operating in central and southern Utah. The following paragraphs describe each of these in detail.

Aneth, UT (SAROAD Number 460960003K03)

The Aneth monitoring station is located on the Navajo Indian Reservation near the western extremity of the Mountain Ute Indian Reservation. It is about 80 km (50 mi) northwest of the Four Corners Power Plant and 64 km (40 mi) northwest of the San Juan Power Plant. The station is situated near the San Juan River near a school and several homes; other homes in the area are widely scattered. The terrain consists of rolling hills and mesas characterized by sandy soil and sparse vegetation. The road to the station is paved, but most other roads are dirt. There is a concentration of oil wells in the vicinity, and livestock grazing is common.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on February 11, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-18 summarizes the data.

TABLE B-18. ANETH SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	39.9	43.2	38.5	28.4	30.8
TSP* (Geometric)	31.6	33.7	33.7	24.6	26.0
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.005	0.003	0.002	0.002	0.002
Cobalt	0.005	0.004	0.005	0.004	0.004
Copper	0.067	0.026	0.025	0.026	0.018
Lead	0.039	0.008	0.015	0.018	0.020
Manganese	0.002	0.002	0.006	0.008	0.007
Nickel	0.004	0.004	0.004	0.005	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.243	0.285	0.406	0.252	0.307
No. of Samples	14	43	37	39	24

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	144.1
Second Highest Daily Value	138.3
Arithmetic Mean Value	36.2
Geometric Mean Value	29.7
Number of Samples	157

Bloomington, UT (SAROAD Number 461280001K03)

The Bloomington monitoring station is located near the Virgin River approximately 19 km (12 mi) west of the proposed Warner Valley Power Project and 56 km (35 mi) southwest of Zion National Park. The station is situated in a small, irrigated farming area surrounded by hilly terrain having dry, sandy

soil and little native vegetation. The area is sparsely populated with homes, but the city of St. George, UT (approximate population of 6,000) is located 8 km (5 mi) north of the station. The road to the station is paved, as are many of the other roads in the area. Interstate 15 is within 4.8 km (3 mi) of the station.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on February 2, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-19 summarizes the data.

TABLE B-19. BLOOMINGTON SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	26.0	32.8	35.8	25.6	24.7
TSP* (Geometric)	24.3	29.0	33.3	22.8	21.5
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.004	0.002	0.005	0.003	0.003
Cobalt	0.006	0.005	0.005	0.004	0.004
Copper	0.066	0.078	0.094	0.125	0.130
Lead	0.021	0.028	0.044	0.025	0.030
Manganese	0.004	0.005	0.010	0.008	0.007
Nickel	0.006	0.004	0.006	0.006	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.303	0.421	0.552	0.317	0.247
No. of Samples	13	28	39	33	39

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	123.0
Second Highest Daily Value	85.6
Arithmetic Mean Value	29.3
Geometric Mean Value	25.8
Number of Samples	152

Escalante, UT (SAROAD Number 460300002K03)

The Escalante monitoring station is located about 97 km (60 mi) north of the Navajo Generating Station, 48 to 64 km (30 to 40 mi) north of the proposed Kaiparowits Plateau development, 56 km (53 mi) west of the Glen Canyon National Recreation Area, and 48 km (30 mi) east of Bryce Canyon National Park. It is a small, irrigated, farming area about 3.2 km (2 mi) south of the town of Escalante, UT (approximate population of 1,000). Areas to the north of the station are forested, but areas to the south generally are flat with large rock mesas, sandy soil, and sparse vegetation. The town contains a

small sawmill. Except in the town, most roads are dirt, and the road to the station is dirt for the last 1.6 km (1 mi).

The station is operated by a field operator employed by Ute Research Laboratories and was activated on January 24, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-20 summarizes the data.

TABLE B-20. ESCALANTE SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	99.6	85.9	69.9	54.3	59.2
TSP* (Geometric)	61.5	59.3	64.6	47.0	50.0
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.004	0.003	0.003	0.002	0.003
Cobalt	0.010	0.006	0.004	0.004	0.004
Copper	0.045	0.062	0.056	0.068	0.071
Lead	0.027	0.017	0.023	0.010	0.011
Manganese	0.006	0.008	0.011	0.012	0.015
Nickel	0.008	0.005	0.005	0.004	0.004
Molybdenum	0.003	0.003	0.003	0.002	0.002
Iron	0.476	0.264	0.656	0.407	0.519
No. of Samples	15	13	37	38	38

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	592.0
Second Highest Daily Value	360.5
Arithmetic Mean Value	67.4
Geometric Mean Value	56.1
Number of Samples	141

Glen Canyon, UT (SAROAD Number 460400003K03)

The Glen Canyon monitoring station is located just outside of the Glen Canyon National Recreation Area about 32 km (20 mi) northwest of the Navajo Generating Station, 32 km (20 mi) south the proposed Kaiparowits Plateau development, and 80 km (50 mi) southeast of Bryce Canyon National Park. Hilly, sandy soil supports only sparse vegetation. There are three homes near the station which is situated about 0.8 km (0.5 mi) from U.S. Highway 89 along a dirt access road.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on October 13, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-21 summarizes the data.

TABLE B-21. GLEN CANYON SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	N/A	N/A	16.3	17.1
TSP* (Geometric)	N/A	N/A	N/A	14.8	15.7
Cadmium	N/A	N/A	N/A	0.001	0.001
Chromium	N/A	N/A	N/A	0.002	0.003
Cobalt	N/A	N/A	N/A	0.004	0.004
Copper	N/A	N/A	N/A	0.011	0.009
Lead	N/A	N/A	N/A	0.008	0.013
Manganese	N/A	N/A	N/A	0.004	0.004
Nickel	N/A	N/A	N/A	0.004	0.004
Molybdenum	N/A	N/A	N/A	0.001	0.002
Iron	N/A	N/A	N/A	0.171	0.149
No. of Samples	N/A	N/A	N/A	21	38

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	36.0
Second Highest Daily Value	33.8
Arithmetic Mean Value	16.8
Geometric Mean Value	15.4
Number of Samples	59

Henrieville, UT (SAROAD Number 460300003K03)

The Henrieville monitoring station is approximately 48 km (30 mi) northwest of the proposed Kaiparowits Plateau development and 16 km (10 mi) east of Bryce Canyon National Park. The station is situated in a small, irrigated, farming area about 1.6 km (1 mi) south of the town of Henrieville, UT (approximate population of 200). The hilly terrain has good ground cover where farming activity is present and to the north and west where it is heavily forested. To the south and east of the station, vegetation is sparse to moderate in a generally arid climate. Most roads in the area are dirt, as is the access road to the station.

The station is operated by a field operator employed by Ute Research Laboratories. It is equipped for various sampling activities, including a regular high-volume air sampler, a two-stage high-volume air sampler (for size-range separation of particulates), and a three-stage, multiday, cascade impactor (for size separation of particulates into three size ranges). The regular high-volume air sampler was activated on January 24, 1976. Commercial electrical power is available. Table B-22 summarizes the data obtained with the regular high-volume air sampler.

TABLE B-22. HENRIEVILLE SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	35.4	45.5	75.7	68.0	41.3
TSP* (Geometric)	30.6	38.1	56.8	58.9	35.0
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.005	0.002	0.002	0.002	0.002
Cobalt	0.007	0.005	0.004	0.004	0.004
Copper	0.056	0.026	0.052	0.039	0.027
Lead	0.035	0.010	0.025	0.007	0.007
Manganese	0.004	0.003	0.013	0.008	0.011
Nickel	0.006	0.004	0.004	0.004	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.323	0.310	0.732	0.371	0.244
No. of Samples	15	27	37	31	33

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	308.0
Second Highest Daily Value	196.9
Arithmetic Mean Value	57.2
Geometric Mean Value	42.4
Number of Samples	143

Huntington Canyon #1, UT (SAROAD Number 460280001K03)

The Huntington Canyon #1 monitoring station is located about 6.4 km (4 mi) west of the Huntington Power Plant. Both the monitoring station and the power plant are situated at the bottom of the canyon, enclosed by the steep, rocky, canyon walls. Vegetation is moderate, with some forested areas. The road up the canyon is paved.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on April 18, 1977. It is equipped with a single high-volume air sampler and a flow recorder. The station is served by commercial electrical power. Since the station was activated after the end of the data collection period covered by this report, no data are included herein.

Huntington Canyon #2, UT (SAROAD Number 460280003K03)

The Huntington Canyon #2 monitoring station is located near the mouth of the canyon containing the Huntington Power Plant. The station is approximately 6.4 km (4 mi) from the power plant and 4.8 km (3 mi) east of the town of Huntington, UT (approximate population of 1,500). The land adjacent to the station is irrigated and farmed, while the unfarmed areas surrounding it are only sparsely vegetated. The road to the monitoring station is paved.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on May 6, 1977. It is equipped with a single high-volume air sampler and a flow recorder. The station is served by commercial electrical power. Since the station was activated after the end of the data collection period covered by this report, no data are included herein.

Navajo Mountain, UT (SAROAD Number 460960001K03)

The Navajo Mountain monitoring station is located on the Navajo Indian Reservation near the Rainbow Bridge National Monument. The station is situated approximately 64 km (40 mi) east of the Navajo Generating Station and 80 km (50 mi) southeast of the proposed Kaiparowits Plateau development. It is an extremely remote and isolated area, with mountainous terrain to the west and Lake Powell to the west and north. There are many rough, steep-walled canyons in the area. The soil is sandy, with only moderate vegetation. The nearest paved road is 56 km (35 mi) from the station, and only a few homes are widely scattered through the area.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on January 30, 1977. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-23 summarizes the data.

TABLE B-23. NAVAJO MOUNTAIN SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	N/A	N/A	N/A	27.8
TSP* (Geometric)	N/A	N/A	N/A	N/A	21.8
Cadmium	N/A	N/A	N/A	N/A	0.001
Chromium	N/A	N/A	N/A	N/A	0.002
Cobalt	N/A	N/A	N/A	N/A	0.004
Copper	N/A	N/A	N/A	N/A	0.031
Lead	N/A	N/A	N/A	N/A	0.005
Manganese	N/A	N/A	N/A	N/A	0.003
Nickel	N/A	N/A	N/A	N/A	0.004
Molybdenum	N/A	N/A	N/A	N/A	0.002
Iron	N/A	N/A	N/A	N/A	0.179
No. of Samples	N/A	N/A	N/A	N/A	13

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	98.6
Second Highest Daily Value	56.4
Arithmetic Mean Value	27.8
Geometric Mean Value	21.8
Number of Samples	13

Oljato, UT (SAROAD Number 460960002K03)

The Oljato monitoring station is located in Monument Valley on the Navajo Indian Reservation. It is about 105 km (65 mi) east of the Navajo Generating Station and 136 km (85 mi) west of the Four Corners Power Plant. The terrain is typically flat, interrupted by massive, rocky mesas and plateaus. The soil is sandy, with sparse vegetation typical of an arid climate. Homes are very widely scattered, although some livestock grazing does occur on the limited vegetation. The highway (U.S. Highway 163) is paved, but all other roads in the area are dirt. The station is situated 0.8 km (0.5 mi) from the highway.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on January 23, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-24 summarizes the data.

TABLE B-24. OLJATO SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	38.3	54.0	40.6	18.9	19.4
TSP* (Geometric)	29.8	38.5	31.1	17.1	17.7
Cadmium	0.001	0.001	0.001	0.001	0.001
Chromium	0.004	0.003	0.002	0.002	0.002
Cobalt	0.006	0.004	0.005	0.004	0.004
Copper	0.055	0.037	0.058	0.039	0.071
Lead	0.027	0.009	0.012	0.010	0.009
Manganese	0.001	0.002	0.006	0.006	0.005
Nickel	0.008	0.004	0.004	0.004	0.004
Molybdenum	0.002	0.002	0.002	0.002	0.002
Iron	0.084	0.355	0.440	0.186	0.259
No. of Samples	19	25	33	33	40

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	207.4
Second Highest Daily Value	193.2
Arithmetic Mean Value	32.1
Geometric Mean Value	25.5
Number of Samples	150

St. George, UT (SAROAD Number 461280002K03)

The St. George monitoring station is located on the top of a mesa about 6.4 km (4 mi) southeast of the city of St. George, UT (approximate population of 6,000). The station is approximately 6.4 km (4 mi) west of the proposed Warner Valley Power Project and 40 km (25 mi) southwest of Zion National Park. The top of the mesa is sandy soil with sparse vegetation, but some of

the areas to the west and north of the mesa are irrigated and used for farming. There are no homes or other buildings within a radius of 3.2 km (2 mi) of the station. However, the road to the station is paved, as are many other roads in the area.

The station is operated by a field operator employed by Ute Research Laboratories and was activated on July 14, 1976. It is equipped with a single high-volume air sampler and a flow recorder. Commercial electrical power is available. Table B-25 summarizes the data.

TABLE B-25. ST. GEORGE SEASONAL AVERAGES ($\mu g/m^3$)

Pollutant	Winter 1975-76	Spring 1976	Summer 1976	Autumn 1976	Winter 1976-77
TSP* (Arithmetic)	N/A	N/A	N/A	16.9	19.3
TSP* (Geometric)	N/A	N/A	N/A	14.7	16.8
Cadmium	N/A	N/A	N/A	0.001	0.001
Chromium	N/A	N/A	N/A	0.002	0.002
Cobalt	N/A	N/A	N/A	0.004	0.004
Copper	N/A	N/A	N/A	0.033	0.023
Lead	N/A	N/A	N/A	0.018	0.013
Manganese	N/A	N/A	N/A	0.008	0.006
Nickel	N/A	N/A	N/A	0.007	0.005
Molybdenum	N/A	N/A	N/A	0.002	0.002
Iron	N/A	N/A	N/A	0.206	0.175
No. of Samples	N/A	N/A	N/A	26	36

* Annual TSP values ($\mu g/m^3$):

Maximum Daily Value	56.8
Second Highest Daily Value	45.9
Arithmetic Mean Value	18.3
Geometric Mean Value	15.7
Number of Samples	62

APPENDIX C

SPECIAL PROJECTS

TWO-STAGE AIR SAMPLER HEAD

As a special project requested by the EMSL-LV, a high-volume air sampler was equipped with a two-stage head. This two-stage head separates the airborne particulates into two size ranges which may prove useful in characterizing and identifying the pollutant materials. Information from this project will be used to assess the value of this size-segregating sampler.

The two-stage head evaluated was a commercially available unit, sometimes referred to as a "cascade impactor head." The first stage was designed to collect material larger than 2 um on a slotted filter measuring 76 by 127 mm (3 by 5 in). The sample airstream with its smaller particles passed through the slits and impacted on a standard 203- by 254-mm (8- by 10-in) high-volume filter. Both of these filters were subjected to normal laboratory analyses for TSP, trace metals, sulfates, and nitrates. A number of these filters also were sent to IIT Research Institute in Chicago for further analyses (Scholl and Draftz, 1977).

This sampler was operated at three sites in an attempt to detect differences in the size distribution and/or composition of the particulates. Initially, the unit was operated at Bloomington, UT, from August 1 to September 7, 1976. It then was moved to Escalante, UT, where it was operated from October 3 through November 24, 1976. On August 24, 1977, the unit was moved to its present location at Henrieville, UT.

Data from this study have been reported to the EMSL-LV for further analysis and interpretation.

THREE-STAGE MULTIDAY CASCADE IMPACTOR

As a special project requested by the EMSL-LV, a three-stage, multiday, cascade impactor was placed into operation at the Henrieville, UT, monitoring station during August, 1977.

This commercial instrument is used to determine the type, size, and amount of particulate matter suspended in the ambient air. The EMSL-LV hopes to use it to help identify and characterize airborne pollutant materials. This special project was implemented to assess the value of this type of instrument as part of the ambient air monitoring network in the Four Corners area.

REFERENCE

Scholl, R.F., and Draftz, R.G., IIT Research Institute, Chicago, IL. Microscopical Analysis of Total Air-Suspended Particulate Samples Collected in Bloomington and Escalante, Utah, IITRI Report No. C6383-1, EPA Order No. CB-7-6096-J, June, 1977, 25 pp.

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